ADDENDUM NO. 1

TO

RED CLAY CONSOLIDATED SCHOOL DISTRICT
RICHARDSON PARK ELEMENTARY SCHOOL
BID PACKAGE 'A'

This addendum is hereby made part of the Project Manual and Drawings dated February 9, 2015.

The Project Manual and Drawings shall be supplemented or amended as specified herein.

This Addendum contains changes to the requirement of the Project Manual. Such changes shall be incorporated into the Contract Documents and shall apply to work with the same meaning and force as if they had been included in the original Documents. Whenever this Addendum modifies a portion of a paragraph of the Project Manual, the remainder of the paragraph affected shall remain in force. Added information is shown as **Bold,** deleted information is shown as ~~strikethrough~~**.**

This Addendum contains changes to the requirement of the Drawings. Such changes shall be incorporated into the Contract Documents and shall apply to work with the same meaning and force as if they had been included in the original Documents. Whenever this Addendum modifies a portion of any drawing, the remainder of the drawing affected shall remain in force. Added, deleted or revised information is shown as "clouded".

The conditions and terms of the basic Contract Documents shall govern work unless otherwise described in this Addendum. Whenever the conditions of work, and the quality or quantity of materials, or workmanship are not fully described in this Addendum, the conditions of work included in the basic Contract Documents for similar items of work shall apply to the work described in this Addendum.

If no similar items of work are included in the basic Contract Document, the best quality of material and workmanship shall apply and all work shall be subject to the written acceptance of the Architect.

THE BID OPENING DATE REMAINS THE SAME. ALL BIDS ARE DUE AT THE RED CLAY CONSOLIDATED SCHOOL DISTRICT OFFICE 1798 LIMESTONE RD, WILMINGTON, DELAWARE 19804 UNTIL 2:00 P.M. LOCAL TIME ON MARCH 13, 2013.

THE LAST DAY FOR QUESTIONS IS FRIDAY, MARCH 6, 2015.

BIDDERS ARE ADVISED THAT THE ONLY RELIABLE SOURCE OF DOCUMENTS FOR THIS SOLICITATION IS THE EDIS FTP SITE. BIDDERS THAT RELY ON INFORMATION PUBLISHED ON ANY OTHER COMMERCIAL WEBSITES DO SO AT THEIR OWN RISK.

BIDDERS CAN CONTACT RICHARD MARTIN TO SCHEDULE A SITE VISIT AT 302-528-0111.

Addendum No. 1 – Consists of the following:

I. Response to Bidders' Questions

II. Revisions to Project Manual/Specifications

III. Revisions to Drawings

I. RESPONSES TO BIDDERS' QUESTIONS

A. N/A

II. REVISIONS TO PROJECT MANUAL/SPECIFICATIONS

A. SECTION 000110 – TABLE OF CONTENTS - DELETE this section in its entirety and INSERT new section attached.

B. SECTION 000115 – LIST OF DRAWINGS - DELETE this section in its entirety and INSERT new section attached.

C. SECTION 001113 – ADVERTISEMENT FOR BID - DELETE this section in its entirety and INSERT new section attached.

D. SECTION 011100 – SUMMARY OF WORK - DELETE this section in its entirety and INSERT new section attached.

E. SECTION 013500 – CONTRACTOR EMPLOYEE BACKGROUND CHECK - DELETE this section in its entirety and INSERT new section attached.

F. ADD the following attached specifications sections:

230200 General Provisions – HVAC
230210 Basic Materials and Methods – HVAC
230215 Valves
230230 Insulation & Covering – HVAC
230400 Heating Generation Equipment
230450 Refrigeration Equipment – HVAC
230451 Variable Refrigerant Flow Split System Heat Recovery with Simultaneous Heating and Cooling
230500 Piping Systems & Accessories – HVAC
230600 Air Distribution & Accessories – HVAC
230730 Terminal Heating and Cooling Equipment
230760 Air Handling Equipment
230900 Automatic Temperature Controls (DDC)
230950 Testing & Balancing of Mechanical Systems

III. REVISIONS TO DRAWINGS

A. DELETE previously issued drawings in their entirety and INSERT new drawings attached.

END OF ADDENDUM NO. 1

Division 0 - Procurement and Contract Requirements

00 01 01 Project Title Page
00 01 10 Table of Contents
00 01 15 List of Drawings
00 11 13 Advertisement for Bids
00 21 13 Instructions to Bidders
00 41 00 Bid Forms
00 52 00 Agreement Forms
00 61 13 Performance and Payment Bond Forms
00 62 16 Certificate of Insurance
00 72 00 General Conditions
00 73 00 Supplementary General Conditions
00 73 43 Wage Rate Requirements

Division 1 - General Requirements

01 11 00 Summary of Work
01 21 00 Allowances
01 22 00 Unit Prices
01 23 00 Alternates
01 26 00 Change Order Procedures
01 26 13 Contractor Compensation
01 29 00 Payment Procedures
01 31 13 Project Coordination Meetings
01 31 19 Preinstallation Meetings
01 31 25 Web-Based Project Management System
01 32 16 Construction Progress Schedule
01 32 19 Submittals Register
01 32 26 Contractors Daily Reports
01 33 00 Submittal Procedures
01 35 00 Contractor Employee Background Check
01 35 23 Safety Program
01 45 00 Quality Control
01 51 13 Temporary Electricity
01 51 23 Temporary Heating, Cooling, and Ventilating
01 52 00 Construction Facilities & Temporary Controls
01 62 00 Material and Equipment
01 71 23 Field Engineering
01 73 29 Cutting and Patching
01 77 00 Contract Closeout

Division 02 - Existing Conditions
02 4100 Demolition

Division 06 - Wood, Plastics, and Composites
06 1000 Rough Carpentry
06 2000 Finish Carpentry

Division 07 - Thermal and Moisture Protection
07 9005 Joint Sealers

Division 08 - Openings
08 1113 Hollow Metal Doors and Frames
08 1613 Fiberglass Doors
08 4313 Aluminum-Framed Storefronts
08 5113 Aluminum Windows
08 7102 Door Hardware
08 8000 Glazing

Division 09 - Finishes
09 2116 Gypsum Board Assemblies
09 2300 Gypsum Plastering
09 3000 Tiling
09 5100 Acoustical Ceilings
09 6500 Resilient Flooring
09 9001 Paints and Coatings

Division 10 - Specialties
10 2800 Toilet Accessories

~~Division 12 - Furnishings~~
~~12 6116 Fixed Audience Seating~~

Division 23 - HVAC
230200 General Provisions – HVAC
230210 Basic Materials and Methods – HVAC
230215 Valves
230230 Insulation & Covering – HVAC
230300 Vibration Isolation – HVAC
230400 Heating Generation Equipment
230410 Heating Generation Auxiliary Equipment
230450 Refrigeration Equipment – HVAC
230500 Piping Systems & Accessories – HVAC
230510 Water Treatment (HVAC)

230600 **Air Distribution & Accessories – HVAC**
230605 **Fans**
230725 **Terminal Heating Units**
230730 **Terminal Heating and Cooling Equipment**
230760 **Air Handling Equipment**
230900 **Automatic Temperature Controls (DDC)**
230950 **Testing & Balancing of Mechanical Systems**

SECTION 000115 LIST OF DRAWINGS

DRWG NO.	DRAWING NAME	BID PACKS	ISSUE DATE	LATEST REV. DATE
G-001	**Cover Sheet**	**A**	**2/16/15**	**2/27/15**
A-101	**Basement Plan**	**A**	**2/16/15**	**2/27/15**
A-102	**First Floor Plan**	**A**	**2/16/15**	**2/27/15**
A-103	**Second Floor Plan**	**A**	**2/16/15**	**2/27/15**
A-104	**Roof Plan**	**A**	**2/16/15**	**2/27/15**
~~A-401~~	~~Auditorium – Existing Floor Plan~~	~~A~~	~~2/16/15~~	**2/27/15**
~~A-402~~	~~Auditorium – New Seating Layout~~	~~A~~	~~2/16/15~~	**2/27/15**
A-610	**Door Schedule & Details**	**A**	**2/16/15**	**2/27/15**
A-611	**Window Schedule & Details**	**A**	**2/16/15**	**2/27/15**
M-001	**Legend Sheet Mechanical**	**A**		**2/27/15**
MD-100	**Partial Basement Plans Demolition - Mechanical**	**A**	**2/16/15**	**2/27/15**
MD-101	**Enlarged Boiler Room Plans Demolition Mechanical**	**A**		**2/27/15**
MD-110	**Partial First Floor Plan Demolition - Mechanical**	**A**	**2/16/15**	**2/27/15**
MD-111	**Partial First Floor Plan Demolition - Mechanical**	**A**	**2/16/15**	**2/27/15**
MD-112	**Partial First Floor Plan Demolition - Mechanical**	**A**	**2/16/15**	**2/27/15**
MD-120	**Partial Second Floor Plan Demolition - Mechanical**	**A**	**2/16/15**	**2/27/15**
MD-121	**Partial Second Floor Plan Demolition - Mechanical**	**A**	**2/16/15**	**2/27/15**
MD-130	**Partial Roof Plan Demolition - Mechanical**	**A**	**2/16/15**	**2/27/15**
M-100	**Partial Basement Plan - Mechanical**	**A**	**2/16/15**	**2/27/15**
M-110	**Partial First Floor Plan - Mechanical**	**A**	**2/16/15**	**2/27/15**
M-111	**Partial First Floor Plan - Mechanical**	**A**	**2/16/15**	**2/27/15**
M-112	**Partial First Floor Plan - Mechanical**	**A**	**2/16/15**	**2/27/15**
M-120	**Partial Second Floor Plan - Mechanical**	**A**	**2/16/15**	**2/27/15**
M-121	**Partial Second Floor Plan - Mechanical**	**A**	**2/16/15**	**2/27/15**
M-130	**Partial Roof Plan - Mechanical**	**A**	**2/16/15**	**2/27/15**
M-500	**Details & Schedules - Mechanical**	**A**	**2/16/15**	**2/27/15**
P-100	**Basement Plan - Plumbing**	**A**		**2/27/15**
P-101	**Partial Basement Plan - Plumbing**	**A**		**2/27/15**
P-110	**Partial First Floor Plan - Plumbing**	**A**		**2/27/15**
P-111	**Partial First Floor Plan - Plumbing**	**A**		**2/27/15**
P-112	**Partial First Floor Plan - Plumbing**	**A**		**2/27/15**
P-120	**Partial Second Floor Plan - Plumbing**	**A**		**2/27/15**
P-121	**Partial Second Floor Plan - Plumbing**	**A**		**2/27/15**

END OF SECTION

SECTION 001113 ADVERTISEMENT FOR BID

Receipt of Bids

Public notice is hereby given that sealed bids for the following prime contract will be received for the construction of Richardson Park Elementary School located at 16 Idella Avenue, Wilmington, DE 19804. Bids will be received at the Red Clay Consolidated School District Office 1798 Limestone Rd, Wilmington, Delaware 19804 until 2:00 p.m. local time on March 13, 2013**5**, at which time they will be publicly opened and read aloud. ***Bidder bears the risk of late delivery. Any bids received after the stated time will be returned unopened.*** The time and location of the bid opening may be extended with a minimum of 2 calendar days notice to the Bidders.

Contract: A-01 GLASS & GLAZING
Contract: A-02 MECHANICAL & CONTROLS

Bidding Document

Documents may be viewed and downloaded at EDiS' FTP site. Bidders requesting the log on information may obtain user name and password permission by contacting Jackie McKee with EDiS Company at jmckee@ediscompany.com or 302-421-2962. Each contractor will be required to provide the following information prior to receiving the log on information: company name, contact name, email address, phone number, fax number and postal mailing address.

It is the responsibility of each bidder to review and coordinate all Project Documents. This includes plans, specifications and addendums. Documents may also be examined at the office of the Construction Manager, EDIS Company, 110 S. Poplar Street, Suite 400, Wilmington, Delaware 19801; the Architect, ABHA Architects, 1621 North Lincoln Street, Wilmington, DE 19806; and the office of Delaware Contractors Association, 527 Christiana Stanton Road, Newark, Delaware 19713.

Bid Security

A bid security in the amount of 10% of the bid including all alternates, plus a consent of surety must accompany each bid. Bid Security shall specify the Owner as the obligee. Owner: Red Clay Consolidated School District, 1502 Spruce Avenue, Wilmington, Delaware 19805.

Pre-Bid Meeting

A pre-bid meeting will be held at **Richardson Park Elementary School located at 16 Idella Avenue, Wilmington, DE 19804**, on **February 26, 2015 at 3:30 PM local time**. A site visit will be conducted immediately following the pre-bid meeting. Attendance is highly suggested but not mandatory.

Questions

Please contact EDiS Company, Mark Grunza at mgrunza@ediscompany.com or 302-421-2956 with questions.

Conformance to the Delaware Architectural Accessibility Act and the standards of the

Architectural Accessibility Board is required on the Project.

Prevailing Wage Rates, as described by Delaware Law, must be adhered to where applicable.

The Red Clay Consolidated School District reserves the right to waive irregularities and to reject any and all bids.

END OF SECTION

Contract: A*-021 – *Mechanical & Controls

BID FORM

For Bids Due: _____ To: _____

_____

_____

Name of Bidder: _____

Bidder Address: _____

_____

Contact Name: _____ E-Mail Address: _____

Delaware Business License No.:_____ Taxpayer ID No.: _____

(Other License Nos.): _____

(A copy of Bidder's Delaware Business License must be attached to this form.)

Phone No.: ( ) _____ - _____ Fax No.: ( ) _____ - _____

The undersigned, representing that he has read and understands the Bidding Documents and that this bid is made in accordance therewith, that he has visited the site and has familiarized himself with the local conditions under which the Work is to be performed, and that his bid is based upon the materials, systems and equipment described in the Bidding Documents without exception, hereby proposes and agrees to provide all labor, materials, plant, equipment, supplies, transport and other facilities required to execute the work described by the aforesaid documents for the lump sum itemized below:

$_____ ($_____)

ALTERNATES

Alternate prices conform to applicable project specification section. Refer to specifications for a complete description of the following Alternates. An "ADD" or "DEDUCT" amount is indicated by the crossed out part that does not apply.

1. Base Bid shall be completed during normal work hours, which for this project are from 7:00 p.m. to 3:30 p.m. Alternate #1 is for additional cost to be completed during 2nd shift. The Second Shift work will be scheduled from 2:30 pm to 11:00 pm.

Add/Deduct _____($_____)

UNIT PRICES: NONE

Unit Prices _____($_____)
NOTE: The difference in price between Add and Deduct in the above Unit Prices should not exceed ten percent (10%).

I/We acknowledge Addendums numbered _____ and the price(s) submitted include any cost/schedule impact they may have.

This bid shall remain valid and cannot be withdrawn for sixty (90) days (Project Manager's Note: Verify and coordinate with Section 00100 Instruction to Bidders.) from the date of opening of bids, and the undersigned shall abide by the Bid Security forfeiture provisions. Bid Security is attached to this Bid (if required).

The Owner shall have the right to reject any or all bids, and to waive any informality or irregularity in any bid received.

This bid is based upon work being accomplished by the Sub-Contractors named on the list attached to this bid.

The undersigned represents and warrants that he has complied and shall comply with all requirements of local, state, and national laws; that no legal requirement has been or shall be violated in making or accepting this bid, in awarding the contract to him or in the prosecution of the work required; that the bid is legal and firm; that he has not, directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken action in restraint of free competitive bidding.

Upon receipt of written notice of the acceptance of this Bid, the Bidder shall, within twenty (20) calendar days, execute the agreement in the required form and deliver the Contract Bonds, and Insurance Certificates, required by the Contract Documents.

I am / We are an Individual / a Partnership / a Corporation

By _____ Trading as _____
(Individual's / General Partner's / Corporate Name)

_____
(State of Corporation)

Business Address:_____
_____
_____
_____

Witness: _____ By: _____
(Authorized Signature)

(SEAL)

_____
(Title)

Date: _____

ATTACHMENTS

Sub-Contractor List
Non-Collusion Statement
Bid Bond
Consent of Surety
(Others as Required by Project Manuals)

SUBCONTRACTOR LIST

In accordance with Title 29, Chapter 6962 (d)(10)b Delaware Code, the following sub-contractor listing must accompany the bid submittal. The name and address of the sub-contractor must be listed for each category where the bidder intends to use a sub-contractor to perform that category of work. In order to provide full disclosure and acceptance of the bid by the Owner, **it is required that bidders list themselves as being the sub-contractor for all categories where he/she is qualified and intends to perform such work.**

Subcontractor Category	Subcontractor	Address (City & State)	**Subcontractors tax payer ID # or Delaware Business license #**
1. Mechanical Unit Supplier	_____	_____	_____
2. Demolition Contractor	_____	_____	_____
3. Controls Contractor	_____	_____	_____
4. Plumbing Contractor	_____	_____	_____
5. Balancing Contractor	_____	_____	_____

NON-COLLUSION STATEMENT

This is to certify that the undersigned bidder has neither directly nor indirectly, entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this proposal submitted this date _____.

All the terms and conditions of Contract: _____ have been thoroughly examined and are understood.

NAME OF BIDDER: _____

AUTHORIZED REPRESENTATIVE (TYPED): _____

AUTHORIZED REPRESENTATIVE (SIGNATURE): _____

TITLE: _____

ADDRESS OF BIDDER: _____

_____

_____

PHONE NUMBER: _____

Sworn to and Subscribed before me this _____ day of _____ 20_____.

My Commission expires _____. NOTARY PUBLIC _____.

THIS PAGE MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.

BID BOND

TO ACCOMPANY PROPOSAL
(Not necessary if security is used)

KNOW ALL MEN BY THESE PRESENTS That: _____of _____in the County of _____ and State of _____ as Principal, and _____of _____in the County of _____ _____ and State of _____ as Surety, legally authorized to do business in the State of Delaware ('State"), are held and firmly unto the _____ in the sum of _____ _____ Dollars (S_____), or percent not to exceed _____ _____ Dollars (S_____) of amount of bid on Contract No. _____ to be paid to the _____ for the use and benefit of the _____ for which payment well and truly to be made, we do bind ourselves, our and each of our heirs, executors, administrators. and successors, jointly and severally for and in the whole firmly by these presents.

NOW THE CONDITION OF THIS OBLIGATION IS SUCH That if the above bounden Principal who has submitted to the _____ a certain proposal to enter into this contract for the furnishing of certain material and/or services within the State, shall be awarded this Contract, and if said Principal shall well and truly enter into and execute this Contract as may be required by the terms of this Contract and approved by _____ this Contract to be entered into within twenty days after the date of official notice of the award thereof in accordance with the terms of said proposal, then this obligation shall be void or else to be and remain in full force and virtue.

Sealed with _____seal and dated this____day of _____in the year of our Lord two thousand and _____(20__).

SEALED, AND DELIVERED IN THE PRESENCE OF

_____
Name of Bidder (Organization)

Corporate Seal

By:_____
Authorized Signature

Attest _____

_____
Title

_____
Name of Surety

Witness_____

_____

_____
Title

CONSENT OF SURETY

DATE_____

To: _____

Gentlemen:

We, the _____

_____
(Surety Company's Address)

_____

a Surety Company authorized to do business in the State of Delaware hereby agrees that if

_____
(Contractor)

_____
(Address)

_____

is awarded the Contract No. _____

We will write the required Performance and/or Labor and Material Bond required by Paragraph 9 of the Instructions to Bidders.

_____
(Surety Company)

By _____
(Attorney-in-Fact)

SECTION 101100 - SUMMARY OF WORK

1. RELATED DOCUMENTS

1.1 Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Sections, apply to work of this Section.

2. CONTRACTS

2.1 The work will be performed under separate prime contracts managed by the Construction Manager.

3. ALTERATIONS & COORDINATION

3.1 Contractor shall be responsible to coordinate their work with the work of others, including, but not limited to, the preparation of general coordination drawings, diagrams and schedules, and control of site utilization, from the beginning of activity, through project close-out and warranty periods.

4. KNOWLEDGE OF CONTRACT REQUIREMENTS

4.1 The Contractor and his Subcontractors, Sub-subcontractors and material men shall consult in detail the Contract Documents for instructions and requirements pertaining to the Work, and at his and their cost, shall provide all labor, materials, equipment and services necessary to furnish, install and complete the work in strict conformance with all provisions thereof.

4.2 The Contractor will be held to have examined the site of the Work prior to submitting his proposal and informed himself, his Subcontractors, Sub-subcontractors and material men of all existing conditions affecting the execution of the Work.

4.3 The Contractor will be held to have examined the Contract Documents and modifications thereto, as they may affect subdivisions of the Work and informed himself, his Subcontractors, Sub-subcontractors and material men of all conditions thereof affecting the execution of the Work.

4.4 The Scope of Work for the Contract is not necessarily limited to the description of each section of the Specifications and the illustrations shown on the Drawings. Include all minor items not expressly indicated in the Contract Documents, or as might be found necessary as a result of field conditions, in order to complete the Work as it is intended, without any gaps between the various subdivisions of work.

4.5 The Contractor will be held to be thoroughly familiar with all conditions affecting labor in the area of the Project including, but not limited to, Unions, incentive pay, procurements,

living, parking and commuting conditions and to have informed his Subcontractors and Sub-subcontractors thereof.

5. CONTRACT DOCUMENTS INFORMATION

5.1 The Contract Documents are prepared in accordance with available information as to existing conditions and locations. If, during construction, conditions are revealed at variance with the Contract Documents, notify the Construction Manager immediately, but no more than three (3) days from the day the variance is first known. Failure to give timely notice shall operate to waive any claim Contractor might otherwise have for an adjustment to Contract Time or Sum as a consequence of such variance.

5.2 The Specifications determine the kinds and methods of installation of the various materials, the Drawings establish the quantities, dimensions and details of materials, the schedules on the Drawings give the location, type and extent of the materials.

5.3 Dimensions given on the Drawings govern scale measurements and large scale drawings govern small scale drawings, except as to anything omitted unless such omission is expressly noted on the large scale drawings.

5.4 The techniques or methods of specifying to record requirements varies throughout text, and may include “prescriptive”, “open generic/descriptive”, “compliance with standards”, “performance”, “proprietary”, or a combination of these. The methods used for specifying one unit of work has no bearing on requirements for another unit of work.

5.5 Whenever a material, article or piece of equipment is referred to in the singular number in the Contract Documents, it shall be the same as referring to it in the plural. As many such materials, articles or pieces of equipment shall be provided as are required to complete the Work.

5.6 Whenever a material, article or piece of equipment is specified by reference to a governmental, trade association of similar standard, it shall comply with the requirements of the latest publication thereof and amendments thereto in effect on the bid date.

5.7 In addition to the requirements of the Contract Documents, Contractor’s work shall also comply with applicable standards of the construction industry and those industry standards are made a part of Contract Documents by reference, as if copied directly into Contract Documents, or as if published copies were bound herein.

5.8 Where compliance with two (2) or more industry standards, contract requirements, or sets of requirements is specified, and overlapping of those different standards or requirements establishes different or conflicting minimums or levels of quality, then the most stringent requirements, which are generally recognized to be also the most costly, is intended and

will be enforced, unless specifically detailed language written into the Contract Documents clearly indicates that a less stringent requirement is to be fulfilled. Refer apparently equal but different requirements, and uncertainties as to which level of quality is more stringent, to Architect for decision before proceeding.

5.9 Reference standards referenced directly in Contract Documents or by governing regulations have precedence over non-reference standards which are recognized in industry for applicability of work.

5.10 Contractor's bid is based on the complete set of Contract Documents including documents not specifically issued as part of the bid pack but referenced in same.

6. SCOPE OF WORK/GENERAL INFORMATION

6.1 A Scope of Work for each contract to be awarded on the project follows in this section. When a Contract has been awarded to a Contractor, the successful Contractor will be listed after the title of the Contract. When no Contract has yet been awarded, no Contractor's name will be listed. Previous Scopes of Work include addendum changes.

6.2 Contractor is responsible for performing the work listed in the Summary of Work for his contract. Contractor is also responsible for knowing the work that has been assigned to preceding contracts. No additional compensation or extension of time will be allowed a Contractor due to his ignorance of the work assigned to his Contract or to other contracts which may affect his work. The Contractor is responsible, however, for all items which are covered in the Specifications and Drawings relating to their Contract if not specifically mentioned in the Summary of Work.

6.3 The Construction Manager will provide onsite a source for temporary electric, temporary water and portable sanitation facilities only. It is each Contractor's responsibility to make the necessary connections, including all material for temporary electric and water. Please note that utility charges for office trailers will be the responsibility of the individual Contractors.

6.4 A dumpster will be provided on site for free use by Contractors to dispose of non-hazardous, common, work-related refuse. Clean-up is the responsibility of each Contractor. Clean up shall be performed on a daily basis. Contractors not complying will be advised in writing and back charged for all costs associated with the cleanup of their work.

6.5 Contractors are reminded that there are limited storage areas available on site. Offsite storage will be the responsibility of each individual Contractor.

6.6 Office trailer permits off site will be the responsibility of each individual Contractor. On site Contractor's field offices, one (1) per Contractor, if required, will be located as

directed by the Construction Manager.

6.7 Contractor will be prepared to discuss and submit a detailed project schedule seven (7) days after receipt of Notice to Proceed and to begin its submittal process. The Project Schedule is an integral part of this contract. Certain construction sequences and priorities must take place in order to meet the target dates. Concentrated work periods will occur and each Contractor is responsible to staff the project as required by the current Construction Schedule or as directed by the Construction Manager. Contractor will cooperate with the Construction Manager in planning and meeting the required sequences of work and Project Schedule as periodically updated by the Construction Manager.

6.8 All bids must include insurance limits in accordance with Article 11 of the Section 007300 SUPPLEMENTARY CONDITIONS.

6.9 Hoisting, scaffolding and material handling is the responsibility of each Contractor, unless otherwise noted.

6.10 Contractor will be responsible for layout of its own work. The Construction Manager will provide benchmark and layout of the building line.

6.11 Contractor will be responsible to keep clean public roadways soiled by construction traffic on a daily basis. If cleaning is not done, the Construction Manager may perform the cleaning on an overtime basis and back charge the Contractor responsible.

6.12 Contractor Scopes of Work and Schedule are interrelated. Familiarity with each is required.

6.13 The Construction Manager will provide testing services for soil, concrete and steel. Other testing as required by the Contract Documents will be in accordance with the technical specifications and/or the individual scope of work. Refer to Specification Section 004500 - QUALITY CONTROL.

6.14 Safety is the responsibility of each individual Contractor. The project will be governed under the guidelines of OSHA.

6.15 Inter-Contractor shop drawing distribution will be performed by the Construction Manager. Contractor is individually responsible for either coordinating his work with these distributed drawings or notifying the Construction Manager, in writing, of any discrepancies.

6.16 Coordination with other trades will be required. The Contractor will be required to attend periodic coordination meetings with other trades where requirements, conflicts and coordination issues will be discussed and resolved. Attendance when requested will

be mandatory. If inter-Contractor coordination is not satisfactorily performed, the conflicting Contractors shall mutually share the cost to relocate and/or reinstall their work.

6.17 Contractor shall submit a schedule of values to the Construction Manager prior to the submission of their first invoice for approval on AIA G702/CMa, Application for Payment and G703, Continuation Sheet.

6.18 Contractor is expected to review and coordinate its Work with the complete set of Contract Documents, including all items noted as by his trade whether or not shown on that particular set of drawings. Documents are available at the site for review.

6.19 Contractor is responsible for obtaining all necessary permits required for his work, including street permits. Unless otherwise noted, building permit shall be secured by the Construction Manager. Any subcontractor who will be restricting access to street, right of way or adjacent property must notify the Construction Manager 48 hours in advance.

6.20 Contractor's License: Submit a copy of all business licenses required by local and state agencies.

6.21 Contractor shall absorb, without additional compensation, any and all costs of working beyond normal hours to maintain job progress in accordance with the current construction schedule.

6.22 No asbestos or PCB's in or on any material or equipment will be accepted or allowed on this project. All hazardous materials will be treated in accordance with all State and Federal regulations.

6.23 Daily cleanup of the work is the responsibility of each individual Contractor which includes broom cleaning of their debris as required. Contractor will be individually back charged by the Construction Manager for cleanup not satisfactorily performed by the Contractor.

6.24 In the event asbestos is uncovered, the Contractor shall notify the Construction Manager of the areas requiring removal of asbestos. The Construction Manager shall then coordinate the removal with the Owner.

6.25 This project is to be constructed adjacent to and in existing buildings. Contractor shall exercise all due precautions to minimize noise, air pollution and any other construction hazards which in any way would cause discomfort or danger to the occupants of the existing building in the area.

6.26 Existing mechanical, electrical, plumbing, sprinkler, medical gas, fire alarm, etc. systems will be shut off and locked out by the Owner as required by the Work. Tie-in's and

modifications to those systems will be performed by the specific Contractor associated with the work as indicated in the Contract Documents. Re-energizing and re-startup of all systems should be performed by the Owner.

6.27 The Safety Cable System shall not be altered or removed without a written request submitted to the Project Manager with a copy to the Field Manager. It shall be the responsibility of each and every Contractor that is removing or altering the Safety Cable System to maintain the fall protection safety provided by the safety cable and not leave the area unprotected. Each and every Contractor shall be responsible to re-install the Safety Cable System immediately after work is completed. Each and every Contractor shall be responsible to re-install the Safety Cable System in accordance to OSHA standards.

6.28 Normal work hours for this project are from 7:00 p.m. to 3:30 p.m. Any work to be performed outside of these hours must receive prior approval from the Construction Manager. Requests to work beyond normal work hours shall be submitted at least 48 hours prior.

6.29 Contractor is responsible for having a competent project superintendent/foreman on-site during all work performed under its contract.

6.30 In the event the Contractor has non-English speaking employees or subcontractors on the project, they shall have a superintendent or foreman on site, at all times, who speaks English and can communicate with Contractor's employees. Should the Contractor fail to meet this requirement, at any time, Construction Manager may direct all Work to stop until the proper supervision is on site. The Contractor will be responsible for maintaining the project work schedule and make up at its own expense, any delay to the Schedule resulting from the work stoppage.

6.31 Punch List Procedures: Contractor shall be given a copy of the punch list with his appropriate work identified. Contractor shall have nine (9) calendar work days to complete its punch list work. On the 10th day or as determined by the Construction Manager, the Construction Manager shall employ other contractors, as required, to complete any incomplete punch list work and retain from the appropriate Contractors retainage all costs incurred.

6.32 Contractor shall provide the necessary safety barricades and railings required to complete their work and comply with all OSHA, local code and contract specifications.

6.33 **Liquidated Damages:** Contractors are responsible to provide sufficient manpower and equipment and materials to complete work as shown in the project schedule. Any delays in completing a phase of work due to issues caused by a contractor will be subject to a penalty of $1,000 per calendar day that the work is not completed following the scheduled completion date of that phase of work.

CONTRACT NO. A 01 – GLASS & GLAZING

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

- Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 024100	Demolition
Section 061000	Rough Carpentry
Section 062000	Finish Carpentry
Section 079005	Joint Sealers
Section 084313	Aluminum Framed Storefronts
Section 085113	Aluminum Windows
Section 088000	Glazing

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide all materials, equipment and labor to complete glass & glazing systems including all flashings, blocking as required, sills, fasteners, weather stripping, aluminum panning, hardware, caulking and associated installation.

2. Provide interior and exterior caulking related to exterior windows.

3. Provide Mock-up/testing as required by the Drawings and Specifications.

4. Provide custom break metal trim and infills as indicated.

5. Provide all aluminum flashing, bituminous coatings, thermal insulation

6. Provide all hoisting/scaffolding related to complete the work of this Contract.

7. Include all necessary design labor and quick-ship costs (if any) to supply windows such that they are ordered and can be delivered to the site for installation during each phase as shown on the construction schedule. Project shall start 6/10/15 and completion 8/15/15.

8. All windows containing asbestos are to be removed by abatement contractor in conjunction with the installation schedule. All other demolition relevant to window replacement to be completed by this contractor.

9. Provide wood blocking, sills and trim at windows as indicated.

10. Window treatments are to remain. If removed for ease, this contractor shall include all costs associated with removal and reinstallation.

11. Sub sills, end damns, sill extensions, flashings, etc. are to be provided by this contractor.

12. Provide factory glazing as indicated.

13. Provide inspect screens.

14. Provide shop drawings in a timeframe that will allow enough lead time to allow review and ordering in a manner that will allow the schedule to be completed without delay.

15. Provide all specified warranties for all specified items such as glass seals, degradation of finishes, fading, flaking etc. including, but not limited to 1 year standard warranty.

16. Provide all materials by specified acceptable manufacturers.

17. Provide weep drainage network and any water entering joints within system as specified.

18. Provide organic coatings.

19. Provide low-e glass.

20. Provide sash locks and limit stops at all windows.

21. Provide shop and touch up for all components.

22. Provide wash down and final cleaning of windows (Interior and exterior) at end of installation.

23. Provide thermal isolation components where penetrations or disruptions of building insulation occur and provide shim spaces at perimeter that maintain continuity of thermal barrier.

24. Provide daily fine cleanup of the work is the responsibility of each individual Contractor which includes broom cleaning of their debris as required. Daily Fine clean up on a daily basis shall be defined as those means/methods utilized to perform the daily cleaning tasks without producing dust, noise and stacking of stored materials. All debris must be removed from the building at the end of each work day.

25. Perform all demolition and disposal of all existing window units and associated materials to a dumpster provided by this contractor. No construction dumpster will be provided by the Construction Manager for the removal of any demolished materials.

26. Base Bid shall be completed during normal work hours, which for this project are from 7:00 p.m. to 3:30 p.m. Alternate #1 is for additional cost to be completed during 2nd shift. The Second Shift work will be scheduled from 2:30 pm to 11:00 pm.

27. Provide all temporary lighting for installations as needed to complete all work in base bid. If Alternate #1 is accepted, this contractor shall include costs for additional lighting as needed to complete this work.

28. All work commenced during a shift must be completed at the end of each shift. No work can be left incomplete, unfinished or unsafe for student use or interaction. This includes, but is not limited to, completion of installation, removal of all debris, material and equipment in each area and the removal of any unsafe conditions created by the installation each shift. All openings are to be watertight at the end of each shift. Any additional labor or materials extending beyond normal working hours will be done so at own risk. No additional compensation will be provided for work not completed as scheduled, on a daily basis.

29. Windows types F, G, H & K have been identified having asbestos associated with these openings. A separate asbestos contractor will provide demolition of these windows. This contractor shall coordinate with asbestos removal contractor to ensure all installations are enclosed with replacement windows as soon as the asbestos has been removed.

30. Include all associated provisions with the understanding that this project includes liquidated damages of $1,000 a day for every day not completed per construction schedule.

31. Provide a $5,000 allowance to be used at the discretion of the Construction Manager.

CONTRACT NO. A 02 – MECHANICAL & CONTROLS

A. Work included in this contract consists of, but is not necessarily limited to, all labor, materials and equipment for:

- Technical Specification Sections:

Division 0	Bidding and Contract Requirements
Division 1	General Requirements
Section 024100	Demolition
Section 062000	Joint Sealers
Section 230200	General Provisions – HVAC
Section 230210	Basic Materials and Methods – HVAC
Section 230215	Valves
Section 230230	Insulation & Covering – HVAC
Section 230300	Vibration and Sound Insulation – HVAC
Section 230400	Heating Generation Equipment
Section 230410	Heating Generation Auxiliary Equipment
Section 230450	Refrigeration Equipment - HVAC
Section 230500	Piping Systems & Accessories – HVAC
Section 230510	Water Treatment – HVAC
Section 230600	Air Distribution and Accessories – HVAC
Section 230605	Fans
Section 230725	Terminal Heating Units
Section 230730	Terminal Heating and Cooling Equipment
Section 230760	Air Handling Equipment
Section 230900	Automatic Temperature Controls
Section 230950	Testing and Adjusting of Mechanical Units

This contract also includes, but is not necessarily limited to, all labor, materials and equipment for the following:

1. Provide the demolition, purchase of all new units and replacement of all mechanical systems as indicated on the Drawings and in the Specifications.

2. Division 26 of the specifications should be reviewed as it relates to the power wiring and other requirements for HVAC equipment including the coordination of furnishing and installing motor starters as provided in the specifications.

3. Provide the removal of existing and installation of all equipment bases and housekeeping pads as indicated. Include removal of debris to this contractor's supplied dumpster. CM Will not provide any dumpsters for demolition debris.

4. Provide permitting and inspections as required.

5. This Contractor shall be responsible to designate an individual within his organization, intimately familiar with this project and assigned on site, to act as the System Start-up Coordinator. This individual must be pre-approved by the Construction Manager. This individual's responsibilities shall include, but not be limited to, coordinating the start-up of all mechanical equipment, including the coordination between the Electrical Contractor, the Controls Contractor, and all testing, adjusting and balancing work. This individual shall report on a weekly basis, in written form, to the Construction Manager. These reports shall include a summary of current conditions including manufacturers' start-ups, systems' deficiencies noted to date and the remediation of same, coordination issues between trades, system interfacing and forecasting, as necessary to project the completion of each individual system within the building.

6. Provide penetrations through wall, floors, etc. including cutting, patching, insulating and fire safing.

7. Provide testing adjusting and balancing as specified. Include water and air balancing completed by certified balancer. Report is due prior to New Castle county final inspection.

8. Provide daily fine cleanup of the work is the responsibility of each individual Contractor which includes broom cleaning of their debris as required. Daily Fine clean up on a daily basis shall be defined as those means/methods utilized to perform the daily cleaning tasks without producing dust, noise and stacking of stored materials. All debris must be removed from the building at the end of each work day.

9. All guarantees and warranties to begin at the substantial completion of the entire project. Maintain equipment prior to substantial completion.

10. Provide all lifts, hoisting, rigging and scaffolding needed to complete all of scope of work.

11. Provide, coordinated design, supply, and installation of automatic temperature controls. This contractor is responsible for coordination and installation of ATC system as specified under this section.

12. Provide all ductwork, flex duct, grilles and diffusers and all associated supports, hangars and bracing. Any blocking associated with the curbs or bracing shall be provided by this contractor. For blocking installations, reference section 06200.

13. Provide new louvers and adjustments to existing louvers and vents related to HVAC operations.

14. Coordinate damper size, location and type of damper with architectural drawings.

15. Temporary heat and ventilation installation, maintenance and removal. Refer to Division 1, Specification section 015123 - TEMPORARY HEAT AND VENTILATION, for specific scope.

16. Provide roof curbs and include all costs associated with roof patching, flashings and counter flashings and any temporary roof enclosure needed to perform this work to ensure water tight openings at all times. Any blocking associated shall be provided by this contractor. For blocking installations, reference section 06200.

17. Provide access panels as required.

18. Provide as- built drawings.

19. This contractor is responsible to accept delivery and/or provide storage of all equipment and then transportation to curb side of job site and provide installation of all systems. No additional costs for multiple deliveries in order to maintain sequence will be provided.

20. Provide coordination with the owner's ATC Contractor for equipment and materials being provided under their contract. This contractor responsible to accept delivery of all equipment at curb side and provide installation.

21. Provide all piping connections from D Mark locations where indicated. All acoustical ceilings will need to be removed, stored, protected and reinstalled by this contractor on an as needed basis to access the tie-in locations as indicated. Any tiles damaged or found to be unsuitable shall be replaced by this contractor at no additional costs to the project.

22. Provide all necessary design labor and quick-ship costs to provide: unit ventilators, roof top units, exhaust fans, heat pumps, coils, unit heaters, hot water cabinet unit heaters, hot water duct coils, ductless split and Finned Tube units for installation in Phase 1 (Summer 2015) areas for installation prior to August 2015 as stated in the project schedule. All other mechanical units, such as boiler and pumps must be ordered and delivered to site for installation in Phase II (Summer 2016).

23. Provide pricing for all alternates as described in Section 012300-Alternates.

24. Perform all demolition and disposal of all existing units and associated connections to a dumpster provided by this contractor. No construction dumpster will be provided by the Construction Manager for the removal of any demolished materials. This includes Mechanical, plumbing and control systems and components.

25. Provide all patching of walls and floors. Patching is to provide smoke/seal through walls and floors.

26. Provide protection of adjacent floors and finishes during demolition of mechanical and plumbing fixtures, equipment, pipe, etc. Protection shall consist of 20 mill poly layered under Masonite that has been duct taped for access in all areas affected including hallways leading to rooms.

27. Provide labeling, valve charts or tags as indicated.

28. Domestic plumbing will be issued in Bid Pac "B". No costs associated with domestic piping shall be included in base bid.

29. Provide an allowance to install two (2) 6" valves and four (4) 1 1/2" valves on the piping mains to the classrooms in the event that existing valves do not hold. Any allowance costs not utilized will be returned to owner at end of project if not utilized.

30. Base Bid shall be completed during normal work hours, which for this project are from 7:00 p.m. to 3:30 p.m. Alternate #1 is for additional cost to be completed during 2nd shift. The Second Shift work will be scheduled from 2:30 pm to 11:00 pm.

31. Provide all temporary lighting for installations as needed to complete all work in base bid. If Alternate #1 is accepted, including alternate costs for additional lighting as needed to complete this work.

32. All work commenced during a shift must be completed at the end of each shift. No work can be left incomplete, unfinished or unsafe for student use or interaction. This includes, but is not limited to, completion of installation, removal of all debris, material and equipment in each area and the removal of any unsafe conditions created by the installation each shift. Any additional labor or materials extending beyond normal working hours will be done so at own risk. No additional compensation will be provided for work not completed as scheduled, on a daily basis.

33. Provide intake/exhaust duct system at exhaust fans and outside air intakes as indicated.

34. Provide a pate pipe curb assembly at roof penetrations.

35. Provide blank plates where indicated.

36. Remove and reinstall piping enclosures (horizontal and vertical) to provide removal, reinstallation of piping, power & controls. If additional piping enclosures are required, this contractor shall provide as indicated on M-500 – Unit Ventilator Piping Enclosure Detail. This contractor must coordinate with Electrical contractor that will be awarded in Bid Pac "B".

37. All rooftop equipment or components must have specified equipment support rails and/or pipe supports, flashings and counter flashings provided by this contractor. Any

blocking associated with the curbs or bracing shall be provided by this contractor. For blocking installations, reference section 06200.

38. Provide drip pans where specified.

39. Provide all factory startup of equipment as specified.

40. Abandon, demolish and cap steam and condensate lines as indicated.

41. Provide wall sleeve to connect outdoor air opening on unit ventilator to outdoor grilles.

42. Provide all work associated with the following notes: Mechanical notes, Mechanical demolition notes and Boiler Room Notes located on the Mechanical drawings.

43. Include all associated provisions with the understanding that this project includes liquidated damages of $1,000 a day for every day not completed per construction schedule.

44. Provide a $10,000 allowance to be used at the discretion of the Construction Manager.

END OF SECTION

SECTION 013500 – CONTRACTOR EMPLOYEE BACKGROUND CHECK

1. It is the contractor's responsibility to perform background checks and screen all employees working onsite. The background check must include checking for a previous history of Child Abuse Convictions, Child Molestation Convictions, Felony Convictions, and Drug Convictions within the last 5 years. Any employee with any of these convictions may not enter the job site or school campus. This background check must be completed and screened by the contractor prior to an employee entering the job site. The Construction Manager, The Owner's representative and the Owner have the right to request that the screening data be submitted on a case by case basis.

2. The contractor is required to provide the Construction Manager written notice verifying background checks were completed and screened by the contractor prior to an employee entering the job site. This notice will contain the individual's name and the last four digits of their social security numbers. Notices must be received no later than two (2) working days before access is required. Notices will be forwarded electronically to the Construction Manager. A sample notice follows this section for your reference.

END OF SECTION

Date

Mr. Mark Grunza
Project Manager
EDiS Company
110 South Poplar Street
Wilmington, DE 19805

RE: Richardson Elementary School- Certification of Background Checks

Dear Mr. Grunza:

This letter is to certify that background checks have been completed in accordance with Section 013500 Contractor Employee Background Check. The following individuals are certified as having met the requirements of the specification:

Name	Last 4 SSN
Mr. John Smith	1234

If you require any additional information you may contact INSERT POINT OF CONTACT, PHONE NUMBER AND EMAIL ADDRESS.

Sincerely,

Company

NAME
TITLE
MCS/jr (author's initials in CAPS/typist's initials in lowercase)

PROJECT MANUAL

FOR

RICHARDSON PARK ELEMENTARY SCHOOL RENOVATIONS

RED CLAY CONSOLIDATED SCHOOL DISTRICT — **OWNER**
1502 SPRUCE AVENUE
WILMINGTON, DELAWARE 19805

ABHA ARCHITECTS — **ARCHITECTS**
1621 N. LINCOLN STREET
WILMINGTON, DELAWARE 19806
(302) 658-6426, FAX (302) 658-8431

LARSEN & LANDIS — **STRUCTURAL ENGINEERS**
1615 SUNSET LANE
WILMINGTON, DE 19810
(302) 475-3175

FURLOW ASSOCIATES — **MECHANICAL/ELECTRICAL AND PLUMBING ENGINEERS**
1206 SOCIETY DRIVE
CLAYMONT, DE 19703
(302) 798-3515, FAX (302) 798-9799

ABHA PROJECT NUMBER: 1425

DATE: JANUARY 13, 2015

ADDENDUM NO. 1: FEBRUARY 27, 2015

ABHA architects
1621 N. Lincoln Street
Wilmington, DE 19806
(P)302.658.6426
(F)302.658.8431
abhagen@ABHA.com
www.ABHA.com

DIVISION 23: HVAC

Section 230200 – General Provisions – HVAC

Section 230210 – Basic Materials and Methods – HVAC

Section 230215 – Valves

Section 230230 – Insulation & Covering – HVAC

Section 230300 – Vibration Isolation – HVAC

Section 230400 – Heating Generation Equipment

Section 230410 – Heating Generation Auxiliary Equipment

Section 230450 – Refrigeration Equipment – HVAC

Section 230500 – Piping Systems & Accessories – HVAC

Section 230510 – Water Treatment (HVAC)

Section 230600 – Air Distribution & Accessories – HVAC

Section 230605 – Fans

Section 230725 – Terminal Heating Units

Section 230730 – Terminal Heating and Cooling Equipment

Section 230760 – Air Handling Equipment

Section 230900 – Automatic Temperature Controls (DDC)

Section 230950 – Testing & Balancing of Mechanical Systems

SECTION 23 0200

GENERAL PROVISIONS – HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to work of this Section.

B. This specification or drawing and the design features or resulting construction disclosed, are the property of Furlow Associates, Inc., and shall not be reproduced without written permission.

C. All Mechanical Systems shall be part of and included in all of the following: 23 0200 thru 23 0950

1.2 WORK INCLUDED

A. Provide labor, materials, equipment and supervision necessary to install complete operating HVAC Systems, including all work at the site and within the proposed construction areas to accomplish the required work.

B. Wherever the term "provide" is used, it shall be understood to mean both "furnish" and "install".

1.3 REGULATIONS, CODES AND STANDARDS

A. Work shall be performed in accordance with latest adopted codes, regulations and ordinances by authorities having jurisdiction. Observe all safety regulations.

B. Obtain all permits and inspection certificates and pay all charges.

C. Make or arrange for utility connections and pay all charges.

D. Latest editions of any referenced standards shall govern.

1.4 RELATED WORK

A. Refer to equipment shown or specified in sections of Division 1 thru 14 that will require Mechanical services and provide such service.

B. Refer to work related to HVAC as shown on the following contract drawings:

Architectural

1.5 COORDINATION

A. The Mechanical Contractor is responsible to coordinate all manufacturer's recommended circuit breakers, starters, disconnects and fuse sizes for all equipment. Submission of a shop drawing will certify that this has been completed. Any necessary changes required will be included as part of this contract.

B. Mechanical Contractor shall coordinate scheduling, submittals and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of independent work elements, with provisions to accommodate items that may be installed at a later time.

C. Mechanical Contractor shall verify utility requirements and all characteristics of operating equipment are compatible with the building utilities. Coordinate the work of all sections related and required for installing, connection and placing in service of all equipment.

D. Mechanical Contractor shall coordinate all space requirements, supports and installation of all mechanical, electrical, plumbing and fire protection work, which are indicated diagrammatically on the Drawings. Verify routing of all pipes, ducts, conduits and equipment connections. Maximize accessibility for other work, and service requirements for maintenance and repairs.

E. Obtain written confirmation from all related trade Contractors and the Owner or his representative that requirements, conflicts and coordination issues have been discussed and resolved.

F. Submit coordination drawings to verify access and clearances.

1.6 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installation within unheated shelters.

1.7 SUBMITTALS

A. Shop Drawings:

1. Shop drawings shall be submitted in accordance with Division 1 of these specifications except where herein modified.

2. Shop drawings comprising complete catalog cuts, performance test data for HVAC equipment as required by other sections of Division 23, shall be submitted for review checking. The Contractor shall review these shop drawings for conformance to contract documents prior to submission and affix contractor's signature to each submittal certifying that this review has been done. By approving and submitting shop drawings, product data, samples and similar materials, the Contractor represents that the Contractor has determined and verified materials, field measurements and field construction data that relates to the work, and has checked and coordinated this information with all of the requirements contained in the contract documents for the work of all trades.

   a. The Contractor and equipment manufacturer shall clearly indentify in all submittals and shop drawings any and all applications standards which require additional work to accommodate this equipment and provide a complete and operational system as described in the contract documents.

   b. The Contractor shall be completely responsible for any and all additional costs associated with the changes required by this and all other trades.

3. Submit a 1/4" scale layout of all mechanical equipment rooms. All equipment and pads shall be to scale of equipment being furnished. Obtain size information of any and all equipment from other trades and indicate on drawings. The drawings shall be fully coordinated with all trades prior to submission. Indicate coil pull areas, filter pull areas, maintenance clearances, and access as applicable.

4. All shop drawing submittals shall have the following identification data, as applicable, contained therein or permanently adhered thereto.
   a. Project name.
   b. Project number.
   c. Sub-contractor's, vendor's and/or manufacturer's name and address.
   d. Product identification.
   e. Identification of deviation from contract documents.
   f. Applicable contract drawings and specification section number.
   g. Shop drawing title, drawing number, revision number, and date of drawing and revision.
5. Resubmit revised or additional shop drawings as requested.
6. Wherever shop drawings or vendor's standard data sheets indicate work to be done "by others", it shall be the responsibility of the contractor making the submission to identify by name, the contractor who is to do this work. If the contractor named is other than the contractor making the submission, the shop drawing submission must be reviewed by the named contractor and bear his mark of approval, prior to submission to the Architect/Engineer.
7. Where equipment proposed differs from that shown on the drawings or specified, he shall submit for approval drawings showing the manner in which the layout is affected by the substitution.
8. The Contractor shall keep one copy of approved shop drawings at the job site,, filed in a suitable metal container. The shop drawings shall be cataloged and kept in good repair, and shall be available for use by the Owner, Architect and Engineer.
9. No equipment shall be ordered, fabricated, etc., before approval of shop drawings.

B. Contractor is responsible for the shop drawing coordination and interface with the work of other contracts and adjacent work. The relationship of Contractor’s work shall be verified as it relates to adjacent and critical features of the work of this and all contracts and materials.

C. The Contractor shall submit a complete schedule of all shop drawings required for the scope of work covering all materials and equipment listed in all sections of Division 23, Mechanical, including all documents required for contract closeout, Owner instructions and training, and all turnover items at the completion of the work. This schedule shall be submitted for review and approval within thirty days of contract award and before any subsequent materials are provided for review.

D. The shop drawings provided by the Contractor will be reviewed only once and resubmittals will be reviewed only once. Any other submittals will be billed to the Contractor at the Engineer’s standard rates.

1.8 SITE INSPECTION

A. The Contractor shall visit site, inspect, and become aware of all conditions which may effect the work during the estimation phase of his work prior to bid openings. Investigate utilities, protection requirements for adjacent facilities, storage locations, and access to the construction area.

B. Submission of a bid will be deemed evidence of having complied with this requirement.

1.9 SUBSTITUTIONS

A. Whenever a material, article, piece of equipment or system is identified in the following specification or indicated on the drawings by reference to manufacturers' or vendors' names, trade names, catalog numbers or the like, it is so identified for the purpose of establishing the basis of the Bid.

B. Substitution approval must be obtained and included as an addendum item prior to the submission of the bid. An approved substitution shall not be considered as an approval for the Contractor or an equipment vendor to deviate from the written portion of the specifications unless so stated in the addendum.

C. The drawings illustrate the space allocated for equipment and the Contractor shall install the equipment accordingly. If changes are required in the building or arrangement due to substitution of equipment, the Contractor making the substitution must pay for the necessary modifications.

D. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not be limited to all: space requirements, code clearances, type-horsepower-capacities-number and size of services required from other trades including all auxiliary items provided by this Contractor and all other trades, and all manufacturer's specific equipment applications standards and requirements, for approved equipment including that which is basis of design or a substitution. The bidding related contractor and equipment manufacturers shall clearly identify in all submittals and shop drawings any and all applications standards which require additional work to accommodate this equipment and provide a complete and operational system as described in the contract documents. If the bidding contractor or manufacturer does not comply with these requirements then they shall be completely responsible for any and all additional costs associated with the changes required by this and all other trades.

E. Where only one brand name or manufacturer is identified, no substitutions are permitted

1.10 LUBRICATION

A. Provide and maintain all required lubrication of any equipment operated prior to acceptance by the Owner. Lubrication shall be as recommended by the equipment manufacturer.

B. Provide one year's supply of lubricants to Owner at date of acceptance.

C. Verify that required lubrication has taken place prior to any equipment start-up.

1.11 EQUIPMENT START-UP

A. Verify proper installation by manufacturer or his representative.

B. Advise Construction Manager 2 days prior to actual start-up.

C. Verify proper operation. Obtain signed statement by manufacturer or his representative that equipment is operating within warranty requirements. Submit statement to Construction Manager.

D. Perform field mechanical balancing in accordance with Section 23 0950: TESTING AND BALANCING OF MECHANICAL SYSTEMS.

E. The Mechanical Contractor shall own as part of his work, the following:

Provide one (1) additional drive set, if necessary, to obtain final design balancing requirements. The Mechanical Contractor shall coordinate with Balancing Firm and equipment manufacturer for drive selection, including belts and pulleys.

1.12 OPERATION & MAINTENANCE INSTRUCTIONS

A. Properly and fully instruct Owner's personnel in the operation and maintenance of all systems and equipment.

1. Contractor to demonstrate all systems to Engineer for verification of operation prior to Owner's instruction period.

2. Provide two (2) 4-hour sessions of training to School District Maintenance Staff.

B. Insure that the Owner's personnel are familiar with all operations to carry on required activities.

C. Such instruction shall be for each item of equipment and each system as a whole.

D. Provide report that instruction has taken place. Include in the report the equipment and/or systems instructed, date, contractor, Owner's personnel, vendor, and that a complete operating and maintenance manual has been reviewed.

E. Manual shall include all instructions on operation, maintenance, repair parts list, lubrication requirements, brochures, catalogue cuts, complete schedule of air filters for each unit type in Excel spreadsheet format, wiring diagrams, piping diagrams, control sequences, service requirements, names and addresses of vendors, suppliers and emergency contacts. Three manuals shall be provided.

F. Submit manuals for review prior to operating instruction period. Manuals shall be 8-1/2 x 11" with hard cover, suitably bound.

G. Provide to the Owner any special tools necessary for operation and routine maintenance of any of the equipment.

H. Upon completion of the project, the Mechanical Contractor shall provide a complete set of legible as-built drawings for the Owner.

I. Furnish three (3) copies of a professionally taped video and three (3) copies of professionally prepared drawings demonstrating the following:

- Locations of main shut-off valves.
- Procedures for equipment start-up and seasonal shut-downs.
- Procedures for maintenance.
- Provide written version of all procedures included in video.

The above should cover all equipment/systems including, but not limited to, the following:

- Hot water distribution system.
- Air handlers
- Pumps
- Boilers
- Unit ventilators/fan coil units
- ATC System

1.13 TOOLS

A. All equipment furnished by the Mechanical Contractor which requires special tools or devices other than those normally available to the maintenance or operating staff shall be furnished in duplicate to the Owner, sufficiently marked, packed or boxed for staff usage. The tools provided shall be listed by

the Mechanical Contractor identified as to their use or the equipment applicable in a written transmittal to the Owner.

1.14 CLEANING AND FINISHING

A. After equipment start-up and all operating tests have been made and the system pronounced satisfactory, each respective Contractor shall go over the entire project, clean all equipment, etc., installed by him and leave in a clean and working condition. Any surfaces found marred after this final cleaning shall be refinished or replaced by each Contractor at no cost to the Owner.

B. Provide for the safety and good condition of all materials and equipment until final acceptance by the Owner. Protect all materials and equipment from damage. Provide adequate and proper storage facilities during the progress of the work. Special care shall be taken to provide protection for bearings, open connections, pipe coils, pumps, compressors and similar equipment.

C. All fixtures, piping, finished surfaces and equipment shall have all grease, adhesive labels and foreign materials removed.

D. All piping shall be drained and flushed to remove grease and foreign matter. Pressure regulating assemblies, traps, and similar items shall be thoroughly cleaned. Remove and thoroughly clean and reinstall all liquid strainer screens after the system has been in operation ten (10) days.

E. When connections are made to existing systems, the Mechanical Contractor shall do all cleaning and purging of the existing systems required to restore them to the condition existing prior to the start of work.

F. Clean-up: Remove from the premises, all unused material and debris resulting from the performance of work under this section.

1.15 TEMPORARY USE OF EQUIPMENT

A. The use of permanent equipment and terminal units during the construction period shall be done at the specific direction of the Construction Manager or the Owner's Representative, and as permitted by Local Code.

B. Whenever equipment has been used as directed, the Mechanical Contractor shall change unit filters as required in other sections of Division 23, as well as vacuum clean the interior of all unit enclosures to a like-new condition, including cleaning of coils. Under no circumstances will energy recovery equipment be used for temporary purposes.

C. Mechanical Contractor shall also vacuum clean the interior of all connecting ductwork, fittings, dampers, air outlets and inlets.

D. Mechanical Contractor shall also provide the Owner with a full and complete warranty required in other sections of Division 23 and the General Conditions of the contract.

PART 2 – PRODUCTS

2.1 GENERAL

A. All material and equipment shall be new and of present day manufacture, and shall conform to accepted standards of the trade where such a standard has been established for the particular type of equipment or material.

B. Whenever equipment or material is referred to in the singular, such as "the fan", it shall be deemed to apply to as many such items as necessary to complete the work.

2.2 PRODUCT DELIVERY, STORAGE AND HANDLING

A. During loading, transporting and unloading exercise care to prevent damage to material.

B. Store all materials in dry enclosures or under protective coverings out of way of work progress.

C. Material shall not be allowed to be stored directly on ground.

D. Deliver in manufacturer's original cartons or on skids.

E. Handle and protect so as to prevent damage to product or any surrounding material.

2.3 CONCRETE

A. Concrete shall be in accordance with ACI-613.

2.4 WARRANTY

A. Wherever in the specification sections of this division, reference is made to a specific warranty period, this warranty shall be in addition to and not a limitation of other rights the Owner may have against the Mechanical Contractor under the contract documents.

PART 3 – EXECUTION

3.1 PROTECTION

A. Plug or cap open ends of piping systems, conduit and ductwork.

B. Stored materials shall be covered to prevent damage by inclement weather, sun, dust or moisture.

C. Protect all installed work until accepted in place by the Owner.

D. Plates, polished metal escutcheons, thermostats and other finished devices shall not be installed until masonry, tile, and painting operations are complete unless otherwise protected.

E. Protect all work from operations which may cause damage such as hauling, welding, soldering, painting, insulating and covering.

3.2 WORKMANSHIP

A. Install all work neat, trim and plumb with building lines.

B. Install work in spaces allocated.

C. Cutting and patching shall be performed by skilled tradesmen normally employed for the work involved.

D. This Contractor shall provide a complete weathertight seal to all new systems in the building including the necessary caulking, weather-stripping and insulation.

3.3 EQUIPMENT SETTING

A. Provide as a minimum, a 4 inch concrete pad beneath all floor-mounted equipment. Install anchor bolts in pour.

B. Provide as a minimum, spring vibration isolation under any equipment 10 HP and over and rubber in shear vibration isolation on any equipment up to 10 HP. For further specifications and additional requirements, refer to other sections.

C. Concrete shall be 3,000 psi, 28 day compressive strength in accordance with ACI-613. Reinforce with No. 4 rod 12" on centers both ways or as otherwise detailed.

3.4 FASTENERS, HANGERS AND SUPPORTS

A. Provide all hangers and supports required to suspend, mount, or hang the work.

B. Provide all miscellaneous steel angles, channels, beams, clips, brackets and anchors necessary to hang or support the work. Provide submissions for review.

C. Install concrete inserts before concrete is poured.

D. Drilled inserts shall not be loaded more than 1/4 rated capacity.

E. Power-driven fasteners shall not be allowed for piping larger than 2 inch, or equipment. When used they shall not be loaded more than 1/8 rated capacity or 200 pounds.

F. All hangers, miscellaneous steel, braces and supports shall be galvanized, cadmium plated, or primed steel. Copper tubing shall be supported with copper hangers.

G. Piping shall be supported from adjustable clevis type hangers with insulation pipe saddles or pipe shields in accordance with piping support spacing table on the drawings. Where hangers are 18" or longer provide lateral bracing at every fourth hanger.

H. Support vertical piping at floor levels. Piping shall have split rings.

I. Any lintels required for openings for this work if not indicated on Architectural or Structural drawings shall be provided under this Section.

3.5 SLEEVES

A. Provide each pipe, duct or conduit passing through a masonry or concrete wall, floor or partition with a sleeve made from standard weight steel pipe for pipe or conduit and No. 12 gauge galvanized steel for ducts, with smooth edges, securely and neatly cemented in place. Provide each pipe, duct or conduit passing through a frame or metal partition with a sleeve made from No. 22 gauge galvanized sheet metal, securely fastened in place.

B. Be responsible for the proper location and alignment of all sleeves.

C. Provide hydrostatic seals for sleeves passing through outside walls, either above or below grade, or through hydrostatically sealed slabs or floors on grade. Provide fire-rated seals for all sleeves which penetrate fire-rated walls.

D. Install both piping and sleeve seals so as to maintain integrity of seals with expansion and contraction of piping.

E. Set floor sleeves flush with floor surface in finished areas, 1" above the finished floor in kitchens, cafeterias, and similar service areas unless such areas are slab-on-grade; 1" above the floor in mechanical rooms, pipe chases, pipe spaces and other unfinished areas, unless otherwise indicated, and flush with the underside of slabs. Extend wall and partition sleeves through and cut flush with each surface unless otherwise indicated or specified.

F. Select sleeves two pipe sizes larger than any pipe or conduit that is to remain uncovered, unless otherwise required by the sealing method specified. Where pipes are to be covered, provide sleeves large enough to allow the covering to pass through the sleeves with sufficient clearance for sealing as specified hereinafter. Size sleeves for branch piping from vertical risers large enough to permit vertical expansion at the riser.

G. Select duct sleeve sizes to suit requirements of fire and/or smoke dampers and sealing methods as specified.

H. Place sleeves imbedded in concrete floors or walls in the forms before concrete is poured; sleeves shall have integral waterstop flanges, where they are to receive either watertight or hydrostatic seals.

I. Install sleeves passing through above-grade floors of mechanical rooms, toilet rooms, kitchens or similar service areas where liquid leaks or spillover may occur in a watertight manner. Sleeves shall be such that waterproofing membrane can be flashed around and into the sleeve where necessary.

J. Seal sleeves for pipes or conduit passing through ceiling air plenum walls or the floor above air tight in a manner similar to that specified for fire-rated sleeves.

K. Hydrostatic Sealing Method: Provide compressible synthetic rubber seals, equivalent to LINK SEAL, manufactured by the Thunderline Corporation, or THRUWALL manufactured by O.Z. Gedney. Install seals in accordance with the manufacturer's recommendations to provide air tightness aboveground and hydrostatic sealing belowgrade. Caulking or other type mastic is not acceptable.

L. Fire-Rated Sealing Method:

1. Sleeves, openings and sealants shall comply with applicable codes, recommended practices and standards, and manufacturer's instructions. Fire sealants shall have ability to prevent spread of flame, smoke or water throughout the penetration and shall pass 3 hour test, UL test ASTM E814 and UL 1479.

2. Products: Chase Corporation CTC PR-855, O. Z. Gedney CRS/CAFS, 3M Electro-Products Division Putty 303 or Caulk CP25 penetration sealing kits, General Electric Company sealants type RTV-850, 6428 or 7403, Thunderline Corporation "Link-Seal Pyro-Pak". Installation and type of sealant to be used as recommended by the manufacturer.

3.6 PLATES

A. Provide chrome plated plates wherever piping passes into finished area.

B. Plates shall be securely fastened to piping or building construction.

C. Floor plates shall cover 1 inch sleeve extension.

3.7 OFFSETS, TRANSITIONS, MODIFICATIONS

A. Provide all offsets necessary to install the work and to provide clearance for other trades.

B. Maintain adequate headroom and clearance.

C. Incidental modifications necessary to the installation of the systems shall be made as necessary and as approved by the Architect.

3.8 RECESSES

A. Furnish information to the Construction Manager as to sizes and locations of recesses required to install panels, boxes, and other equipment or devices which are to be recessed in walls.

B. Make offsets or modifications as required to suit final locations.

3.9 LABELING

A. All HVAC equipment such as pumps, fans, air handling units, and devices requiring identification for operating procedures shall be provided with permanent black laminated micarta white core labels with 3/8 inch letters.

B. This shall also apply to all controllers, remote start/stop pushbuttons and equipment cabinets.

C. This shall not apply to individual room thermostats.

D. At all fire damper, smoke damper and combination fire/smoke damper locations, access doors in ductwork shall be identified with a permanent placard of red-white-red laminated commercial grade plastic construction, minimum one-half inch high capital letters, reading, “FIRE DAMPER”, “SMOKE DAMPER”, “FIRE/SMOKE DAMPER” as appropriate for the installation. Attach securely to face of access door with brass screws at each corner, sealed airtight.

3.10 FLASHING AND COUNTERFLASHING

A. Roof curbs, etc., shall have counterflashing fittings. Contractor shall provide flashing.

B. Piping and conduit thru the roof shall be flashed by the Contractor. Provide counterflashing.

C. Provide curbs with base features required to match roof materials, finishes and configuration; e.g., flat, sloped, raised seam, etc.

3.11 ACCESS

A. Locate all equipment, valves, devices and controllers which may need service in accessible places.

B. Where access is not available, access panels shall be provided. Furnish access panels to the Construction Manager for installation.

C. Access panels shall be Nailor-Hart Industries, Karp Co., or Controlled Air Manufacturing Limited, with 16 gauge frames and 14 gauge steel door, prime painted.

D. Maintain access clearances for tube or fan removal, coil pulls, and filter removal.

3.12 WIRING AND MOTOR CONTROLS

A. Packaged equipment shall be furnished with disconnect switches, starters, overloads, factory furnished and wired by the unit manufacturer.

B. Roof-mounted exhaust fans, except utility sets, rated less than 1/2 HP at 115 volts, single phase, shall be furnished with disconnect switches, factory furnished and wired by unit manufacturer.

C. Rooftop equipment shall be furnished with starters, disconnect switches, overloads, factory furnished and wired by unit manufacturer.

D. This Contractor shall furnish all information and assistance required for the Electrical Contractor to purchase all motor starters that are not specified to be part of the mechanical equipment.

E. Control wiring shall be provided under this Division of the work.

F. All wiring shall be in accordance with the National Electrical Code and as recommended by the equipment manufacturer.

3.13 UTILITIES

A. Do not interrupt any utility or service to the Owner without adequate previous notice and schedule.

3.14 OPENINGS – CUTTING, REPAIRING

A. This Contractor shall cooperate with the work to be done under other sections in providing information as to openings required in walls, slabs and footings for all piping, ductwork and equipment, including sleeves where required.

B. Any drilling or cutting required for the performance of work under this Section, shall be the responsibility of this Contractor and the cost thereof shall be borne by him.

C. Holes in Concrete: Sleeves shall be furnished, accurately located and installed in forms before pouring of concrete. This Contractor shall pay all additional costs for cutting of holes as the result of the incorrect location of sleeves. All holes through existing concrete shall be either core drilled or saw cut. All holes required shall have the approval of the Structural Engineer prior to cutting or drilling.

D. It shall be the responsibility of this Contractor to ascertain that all chases and openings are properly located.

3.15 PAINTING

A. Refer to the Construction Manager's Scope of Work.

3.16 GUARANTEE

A. All work shall be guaranteed to be free from defects for a period of one year of operation from date of acceptance by the Owner.

B. Guarantee shall be extended on an equal time basis for all non-operational periods due to failure within the guarantee period.

C. All materials and equipment provided and/or installed under this section of the specifications shall be guaranteed for a period of one year from date of acceptance of the work by the Owner unless otherwise specified in Division 1. Should any trouble develop during this period due to defective materials or faulty workmanship, the Mechanical Contractor shall furnish necessary labor and materials to correct the trouble without any cost to the Owner. Any defective materials or inferior workmanship noticed at time of installation and/or during the guarantee period shall be corrected immediately to the entire satisfaction of the Owner.

D. In the event of occupancy by the Owner prior to final acceptance of the project, the guarantee date for equipment placed in operation shall be mutually agreed to by the Mechanical Contractor and the Owner's representative.

E. Contractor to include an 11 month “walk-thru” of the building systems with representatives of the School District, Architect, Engineer and the Construction Manager. The purpose is to establish a list of corrective work that relates to operational issues, material/installation deficiencies, etc. prior to the expiration of the guarantee period.

3.17 DRAWINGS

A. The Mechanical Systems are indicated on the Contract Drawings. Certain pertinent information and details required by the Mechanical Work appear on the Architectural, Structural and Electrical Drawings; become familiar with all drawings, and incorporate all pertinent requirements.

B. Drawings are diagrammatic and indicate the general arrangement of systems and requirements of the work. Do not scale drawings. Exact locations of fixtures and equipment, not specifically shown, shall be obtained before starting work.

3.18 TESTING AND BALANCING OF MECHANICAL EQUIPMENT

A. Perform field mechanical balancing in accordance with Section 23 0950: TESTING AND BALANCING OF MECHANICAL SYSTEMS.

B. The Mechanical Contractor shall own as part of his work, the following:

Provide one (1) additional drive set, if necessary, to obtain final design balancing requirements. The Mechanical Contractor shall coordinate with Balancing Firm and equipment manufacturer for drive selection, including belts and pulleys.

END OF SECTION 23 0200

SECTION 23 0210

BASIC MATERIALS AND METHODS – HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 23 0200 for HVAC General Provisions.

C. Refer to other sections in Division 23 for materials and methods not specified herein.

1.2 DESCRIPTION OF WORK

A. Included in this Section are the following:

1. Steel Pipe and Fittings
2. Copper Tubing & Fittings
3. Polyvinyl Chloride (PVC) Pipe and Fittings
4. Strainers
5. Thermometers
6. Gauges
7. Test Stations - Pressure/Temperature
8. Isolating Fittings
9. Pipe Saddles
10. Anchors and Guides
11. Unions
12. Motors

1.3 REFERENCE STANDARDS

A. Refer to Section 23 0200 for a general description of requirements applying to this section.

B. Install work to meet the requirements of the following:

1. New Castle County Dept. of License and Inspections
2. International Mechanical Code
3. Gas Utility Company
4. NFPA
5. OSHA
6. ASHRAE
7. Manufacturer's Standardization Society (MSS) of the valve and Fittings Industry, Inc.:

SP-58 Pipe Hangers and Supports Materials, Design and Manufacture.

SP-69 Pipe Hangers and Supports Selection and Application

C. Appliances and materials governed by UL requirements shall meet such requirements and bear the label.

1.4 QUALITY ASSURANCE

A. Provide adequate supervision of labor force to assure that all aspects of the specifications are being fulfilled.

B. Verify that all work and equipment is installed in accordance with manufacturer's warranty requirements.

PART 2 – PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. Water Piping:

1. ASTM A53 seamless, Schedule 40.
2. Fittings up to 2 inch shall be 150 lb. malleable iron, screwed pattern ASME B16.3. Butt weld , ASME B16.9, same thickness as pipe.
3. Fittings 2-1/2" and larger shall be butt weld ASME B16.9, same thickness as pipe.
4. Weld-O-Lets and Thread-O-Lets shall be maximum of two sizes smaller than main size; i.e., maximum of a 2-inch Weld-O-Let on a 3-inch pipe.
5. Thread tape shall be teflon tape, 3 mils minimum thickness.

2.2 COPPER TUBING & FITTINGS

A. Refrigeration Piping:

1. Copper tubing: Type ACR, hard drawn temper.
2. Fitting: Wrought-copper, solder joints, ASME B16.22 or ASME B16.26.
3. Joints: Brazed, American Welding Society (AWS) Class BCUP-5 for brazing filler metal.

B. Water Piping:

1. Tubing: Hard drawn seamless ASTM B-88 Type "L" aboveground.
2. Soft seamless ASTM B-88 Type "K" below-ground.
3. Joint Material: Brazed joints, low temperature silver-bearing solder.
   a. Flux shall be non-toxic type and non-corrosive.
4. Fittings: ASME B16.15, B16.18, B16.22, or B16.26.

C. Condensate Drain Piping:

1. Pipe: Copper tubing Type DWV.
2. Fittings: Wrought copper solder type drainage fittings, ASME B16.23 or B16.29.

2.3 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS

A. Pipe:

1. ASTM D-1785 Schedule 40, Type 1, Grade 1.
2. ASTM D-2665 (DWV) drain, waste and vent.

B. Fittings:

1. ASTM D-2466 Schedule 40
2. ASTM D-2665 DWV.

C. Solvent Cement: ASTM D-2564 Schedule 40 and DWV.

D. Uniformity: To insure installation uniformity, all piping components shall be of one manufacturer.

E. Flux shall be non-toxic type and non-corrosive.

2.4 STRAINERS (WATER)

A. Perforations: .033" pipe size to 2", .057" pipe size 2-1/2" to 4", 1/8" pipe size 6" and up.

B. Self-cleaning "Y" type screwed end up to 2 inch with machined seats with blow-off outlet, stainless steel screen, iron body.

C. Self-cleaning "Y" type flanged 2-1/2 inch and up, with bolted cover flange, blow-off outlet, 125 psi ANSI, brass screen.

D. Duplex basket strainers: Fabricated from cast iron, ASTM A126-B.

1. 125 lb. ANSI class connections, with screwed ends up to 2 inch, flanged ends 2-1/2 inch and larger.
2. Diverter valve shall be a dual cylindrical bronze plug, operated by a common sealed shaft and handle. The handle shall cover the chamber in use to accommodate servicing the chamber that is contaminated.
3. Perforated stainless steel baskets, 0.033 inch diameter holes up to 2 inch; 0.064 inch diameter holes 2-1/2 to 4 inch size units.
4. Shell test pressure shall be equal to 1-1/2 times working pressure; valve seat test pressure shall be equal to rated working pressure.
5. Accessories shall include the following:
   a. Differential pressure indicator mounted to the strainer body to visually indicate when the delta-P is 10 PSID (adjustable).
   b. Magnetic inserts mounted to the baskets to collect metallic particles.
   c. 100% shutoff with special seals within the changeover mechanism.
   d. Air eliminators to automatically vent air from the basket chamber after cleaning.
   e. Mounting studs and brackets for independent support.

E. Manufacturer: Muesco, Sarco, Hoffman Specialties, Metraflex, Armstrong, Watson McDaniel.

2.5 THERMOMETERS

A. Separable socket, inserted into fluid flow, adjustable, hermetically sealed, red or blue indicating fluid, non-toxic, die-cast, baked enamel finish, double strength glass lens, white scale and black graduations.

B. Scale: Heating Water - 30 deg. to 240 deg. F

Dual Temperature Water – 30 deg. to 240 deg. F.

C. Manufacturer: U.S. Gauge, H.O. Trerice, Moeller, Duro, Miljoco Corp., Winter Instruments.

2.6 GAUGES

A. Phosphor bronze bourdon tube, polypropylene case, gasketed glass crystal, aluminum dial, black graduations 4-1/2 inch diameter.

B. Range: 0 to 60 psi, 5 pound intervals, 1/2 pound graduations.

C. Install with bronze gauge cock.

D. Manufacturers: Danton, U.S. Gauge, H.O. Trerice, Moeller, Miljoco Corp., Winter Instruments, Weksler Instruments.

2.7 TEST STATIONS – PRESSURE/TEMPERATURE

A. Provide a SISCO 1/4" or 1/2" NPT fitting (Test Plug) of solid brass at desired indicated locations. Test plug shall be capable of receiving either a pressure or temperature probe 1/8" o.d. Dual seal core shall be neoprene for temperature to 200 degrees F. Nordel to 350 degrees F and shall be rated zero leakage from vacuum to 1000 psig. P/T plug to have grooved cap and chain.

B. P/T plugs shall be provided with extensions as required by insulation.

C. Mechanical Contractor shall also provide the following: pressure gauge adapters with 1/8" o.d. probe, 5" stem pocket testing thermometers for 25° to 125° F (tower and chilled water) for 0° to 220° F (hot water) for 50° - 500° F (temperatures above 220° F).

D. One (1) Master Test Kit shall be furnished to the Owners. Kit shall contain one (1) 2-1/2" test gauge of suitable range, one (1) Gauge Adapter 1/8" o.d. probe, and 5" stem pocket testing thermometers - one (1) 0° - 220° F and one (1) 50° - 550° F.

E. Manufacturer: Sisco P/T Plugs.

2.8 ISOLATING FITTINGS

A. Provide isolating fittings between all sections of dissimilar piping materials or piping and equipment where one material is ferrous and the other is non-ferrous.

B. Manufacturer: Epco Sales, Inc., or insulated unions by Central Plastic Co.

2.9 PIPE SADDLES

A. Steel pipe saddles shall be welded to all black ferrous pipe, 2-1/2" pipe size and larger, at hanger locations, for systems of steam, hot water and other heat conveying systems.

B. Steel pipe saddles shall be welded to all black ferrous hot piping at the pipe support location when roll type hangers or pipe roll supports are employed.

C. The saddles shall be packed with plastic insulating cement, and the saddle shall finish flush with the surface of the specified insulation.

2.10 ANCHORS AND GUIDES

A. Anchors and guides shall be provided to support and maintain pipes in position and properly distribute expansion. The anchors and guides must be securely fastened to the building structure, and must be completely installed before the system is tested.

B. Factory made cast semi-steel or fabricated steel, consisting of a bolted two-section outer cylinder and base with two-section guiding spider bolted or welded tight to the pipe.

C. Guide and spider shall be of sufficient size to clear pipe insulation and long enough to prevent over travel of spider and cylinder. Guides shall not be used as pipe supports.

D. Guides shall be as manufactured by J.J. McNally, Inc., Flexonics, Inc., Metraflex, Hyspan, Twin City Hose, Inc.

2.11 UNIONS

A. Up to and including 2 inch pipe size: Screwed pattern, bronze-to- bronze seat.

B. Above 2 inch pipe size: Flanged pattern, A.S.A. forged steel, with gaskets, bolts and nuts.

C. Copper tubing unions shall have sweated type ends. Flanged unions on copper tubing may be soldered connections.

D. Materials and pressure ratings shall be the same as specified for the respective pipe and fitting system unless otherwise specified.

2.12 MOTORS

A. All single phase and polyphase motors shall be manufactured to incorporate the latest NEMA standards.

B. All single phase and polyphase motors shall have steel frames with ball bearings and copper windings. All motors to have a Class "F" insulation system with a service factor of 1.15.

C. All motors shall be 1725 RPM, 4 pole design, unless otherwise noted on the drawings, or in the equipment specifications.

D. Motors installed indoors and not exposed to moisture shall be open, dripproof, Class B temperature rise based on 40 deg. C maximum ambient temperature.

E. Motors installed outdoors and exposed to moisture shall be totally enclosed, fan cooled, Class B temperature rise based on 40 deg. C maximum ambient temperature.

F. Based on NEMA Standards, motors shall comply with the following minimum nominal efficiencies at full load.

Nominal Efficiencies for "NEMA Premium ™" Induction Motors Rated 600 Volts or Less (Random Wound)						
	Open Drip-Proof			**Totally Enclosed Fan-Cooled**		
HP	**3500 RPM**	**1800 RPM**	**1200 RPM**	**3500 RPM**	**1800 RPM**	**1200 RPM**
1	**82.5**	**85.5**	**77.0**	**82.5**	**85.5**	**77.0**
1.5	**86.5**	**86.5**	**84.0**	**87.5**	**86.5**	**84.0**
2	**87.5**	**86.5**	**85.5**	**88.5**	**86.5**	**85.5**
3	**88.5**	**89.5**	**85.5**	**89.5**	**89.5**	**86.5**
5	**89.5**	**89.5**	**86.5**	**89.5**	**89.5**	**88.5**
7.5	**90.2**	**91.0**	**88.5**	**91.0**	**91.7**	**89.5**
10	**91.7**	**91.7**	**89.5**	**91.0**	**91.7**	**90.2**
15	**91.7**	**93.0**	**90.2**	**91.7**	**92.4**	**91.0**
20	**92.4**	**93.0**	**91.0**	**91.7**	**93.0**	**91.0**
25	**93.0**	**93.6**	**91.7**	**93.0**	**93.6**	**91.7**

Nominal Efficiencies for "NEMA Premium ™" Induction Motors Rated 600 Volts or Less (Random Wound)						
	Open Drip-Proof			Totally Enclosed Fan-Cooled		
HP	3500 RPM	1800 RPM	1200 RPM	3500 RPM	1800 RPM	1200 RPM
30	93.6	94.1	91.7	93.0	93.6	91.7
40	94.1	94.1	92.4	94.1	94.1	92.4
50	94.1	94.5	93.0	94.1	94.5	93.0
60	94.5	95.0	93.6	94.5	95.0	93.6
75	94.5	95.0	93.6	94.5	95.4	93.6
100	95.0	95.4	93.6	95.0	95.4	93.6
125	95.4	95.4	94.1	95.0	95.4	94.1
150	95.4	95.8	94.1	95.8	95.8	95.0
200	95.4	95.8	94.1	95.8	96.2	95.0

G. Motor Characteristics: Refer to Equipment Schedules for specific data.

H. All motors rated less than 1/2HP shall have thermal protection of the auto-reset type as an integral part of the motor.

I. All motors rated 1/2HP and larger shall have thermal protection provided by an external device.

J. Whenever a variable frequency PWM drive is installed to control an AC motor, a maintenance-free, circumferential, conductive micro fiber shaft grounding ring shall be installed on the AC motor drive end to discharge shaft currents to ground. Recommended part: AEGIS SGR™ Bearing Protection Ring, as made by Electro Static Technology. Install in accordance with the manufacturer's written instructions.

PART 3 – EXECUTION

3.1 PIPING SYSTEMS

A. All piping to drain to low points. Low points shall be provided with drain valves with hose thread.

B. All piping shall be arranged to have air vents at high points.

1. Air vents shall be automatic in operation when located in Boiler Rooms, Chiller Rooms and Mechanical Equipment Rooms. All air vents shall be provided with a PVC drain line which shall be routed to the nearest floor drain. Several air vents may be tied together.

2. Air vents shall be manual in operation in all other locations.

C. Do not install trapped lines where water cannot be drained or air can accumulate without being vented.

D. Piping shall run square with building lines.

E. Piping shall not be insulated or covered until tested.

F. Necessary drains, off-sets, vents and drips shall be provided for coordination of the work as part of the contract.

G. Running or close nipples are not permitted.

H. Piping shall not be installed over electrical transformers, panels, switchgear, substations, and control panels. No piping shall be installed in elevator machine rooms.

I. Exposed insulated piping risers in unfinished spaces shall be covered with 22 gauge galvanized steel sleeves from floor to ceiling. Refer to Section: Insulation & Covering – HVAC for additional requirements.

J. Allow clearance for expansion and contraction.

K. Install eccentric piping fittings where change in sizes occurs in piping systems. Tops of pipes shall remain level for hydronic systems. Bottom of pipe shall remain level for steam systems.

L. Install isolating fittings between sections of ferrous and non-ferrous pipe or connected equipment.

M. Do not support piping from other piping, conduits or equipment.

N. Strainers shall be installed on suction of all pumps, inlets of control valves, and where indicated on drawings.

O. Thermometers and gauges shall be installed where indicated on the drawings, required by equipment specifications and where indicated elsewhere in the specifications.

P. Flexible connectors shall be provided on suction and discharge piping of all base mounted pumps.

Q. Unions shall be provided adjacent to all valves, at equipment connections, and where necessary to facilitate dismantling of the piping system.

R. Install expansion joints, expansion compensators, anchors and guides in piping systems as shown on the drawings and in accordance with manufacturer's written instructions.

1. Provide anchors and guides on both sides of the expansion compensator or expansion joint in accordance with EJMA Standards.
2. Provide anchors and moment guides in each pipe, with the first moment guide located the equivalent of four-pipe diameters from the compensator, and the second guide fourteen pipe diameters beyond the first guide.
3. Remove all shipping blocks, stays, setscrews, etc., from all compensators and moment guides. Pipe centerlines shall be aligned.
4. During initial system pressurization, all pipe guides and anchors must be secure and functioning.

S. Material Requirements for Systems:

1. Heating Hot Water Supply & Return Piping:
   a. Schedule 40 black steel.
   b. Type L hard copper.
   c. Grooved End black steel.
2. Make-up Water: Type L hard copper.
3. Dual Temperature Water Supply & Return Piping:
   a. Schedule 40 black steel.
   b. Type L hard copper.

c. Grooved End black steel.

4. AC Condensate Drain (including pumped condensate):

a. Type DWV copper.

b. Schedule 40 PVC.

3.2 TAGS, CHARTS AND IDENTIFICATION

A. See Paragraph "Labeling" in GENERAL PROVISIONS for equipment labeling.

B. Identify each valve in all systems with black, numbered and stamped 1- 1/2" brass or aluminum tags fastened to valve by brass chain and S-hook.

C. Provide 1/8" scale diagrams showing location, number and service or function of each tagged item.

1. Frame diagrams in approved metal frames with clear acrylic front, hinges, and locks.

2. Secure to wall in **Mechanical** Room.

3. Provide two additional separate copies permanently covered and bound.

a. Include one (1) copy in the Operation and Maintenance Manuals.

D. Piping Identification: Identify piping with Seton "Setmark" or Brimar, semi-rigid plastic, wraparound pipe markers with flow arrows and conforming to ANSI A13.1. Locate marker at each valve, changes in direction, where pipes pass thru barriers and every 25' of horizontal runs. Lettering on background shall be in accordance with the following colors:

Legend		Background	Lettering
1.	Gas	- Yellow	- Black
2.	Heating Water Supply	- Yellow	- Black
3.	Heating Water Return	- Yellow	- Black
4.	Dual Temperature Water Supply	- Yellow	- Black
5.	Dual Temperature Water Return	- Yellow	- Black
6.	Cold Water Make-up	- Green	- White
7.	Condensate Return	- Yellow	- Black
8.	Vent	- Yellow	- Black

E. Provide color coded 1” diameter markers on ceiling tile grids to indicate system and valve locations.

Hot Water: - Red

Dual Temperature Water: - Red

F. Manufacturers: Seton “Setmark”, Brimar, B-Line MSI.

G. Painting of Piping and Pipe Insulation:

H. Painting of Ductwork:

3.3 WELDING

A. All concealed and inaccessible black steel piping shall be welded.

B. All black steel piping larger than 1-1/4 inch may be fusion welded.

C. All elbows, tees and branch connections shall be made with welding fittings ANSI B16.9.

D. Welding shall be in accordance with the ASME Boiler and Pressure Vessel Code Section IX.

E. Furnish welder test certificate for review. Certificates of successful qualification by the following organizations shall be acceptable.

1. ASME Boiler and Pressure Vessel Code
2. ANSI Code for Pressure Piping
3. National Certified Pipe Welding Bureau
4. Military Specification MIL-STD-248

3.4 SOLDERING/BRAZING

A. Connections between copper tubing and copper fittings shall be made with the appropriate filler metal. Flux shall be non-corrosive type as recommended by the manufacturer of the filler metal, and conforming to AWS A5.8.

B. Tubing shall be cut square and then reamed and deburred. End of tubing and inside of fitting cup shall be cleaned with steel wool and the flux shall be applied to the clean surface before joining. After joining, the excess filler metal shall be wiped off while still plastic.

C. Silver brazing alloy shall be equal to Easy-Flo by Handy and Harmon or Sta-Brite silver solder and shall be used for joints in:

1. Hot water heating piping
2. Air conditioning condensate drain piping
3. Dual temperature water piping
4. Cold water fill and make-up piping

D. Where the silver brazing is performed in a confined non-ventilated space, a non-toxic, cadmium-free brazing alloy such as braze 560 by Handy & Harman shall be used.

E. Refrigerant piping shall be silver brazed using Harris Sil-Fos 15 or equivalent, with nitrogen purge.

F. Bring joint to solder temperature or brazing temperature in as short a time as possible.

G. Form continuous solder bead or brazing filler bead around entire circumference of joint.

H. Wipe excess solder from joint area while solder is still plastic.

END OF SECTION 23 0210

SECTION 23 0215

VALVES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 23 0200 for HVAC General Provisions.

C. Refer to other sections in Division 23 for materials and methods not specified herein.

1.2 DESCRIPTION OF WORK

A. This Section includes the following:

1. General
2. Hot Water Heating System & Dual Temperature Systems

1.3 QUALITY ASSURANCE

A. Provide adequate supervision of labor force to assure that all aspects of the specifications are being fulfilled.

B. Verify that all work and equipment is installed in accordance with manufacturer's warranty requirements.

PART 2 – PRODUCTS

2.1 GENERAL

A. All gate and globe valves shall be designed for repacking under pressure when fully opened, and shall be equipped with packing suitable for the intended service. When the valve is fully opened, the back seat shall protect the packing and the stem threads from the fluid. All gate and globe valves shall have a gland follower. The pressure- temperature rating of valves shall be not less than the design criteria applicable to all components of the system.

B. Insofar as possible, all valves of the same type shall be of the same manufacture.

C. Valves installed above 7 ft. in Mechanical Rooms shall have chain operators.

D. All valves shall be provided with stem extensions. Valve handle shall be clear of insulation jacket.

E. Manufacturers:

Stockham

Milwaukee

Hammond

Apollo

Watts

Walworth

Nibco

Jamesbury

2.2 HOT WATER HEATING SYSTEM & DUAL TEMPERATURE SYSTEM

A. Gate Valves - 2" and smaller:

Valves 2" and smaller shall be of Class 150 with body and union bonnet of ASTM B-62 cast bronze composition, threaded or solder ends, solid disc, copper-silicon stem, brass packing gland, Teflon- impregnated packing, and malleable handwheel.

Recommended valves:

Threaded:	Solder:
Stockham B-120 (RS)	Stockham B-124
Stockham B-130 (RS)	----
Hammond IB629	IB648
Nibco T134	S134

Class 200 valves meeting the above specifications may be used where pressure requires - Stockham B-132 (threaded - RS).

B. Ball Valves - 3" and smaller:

Valves 3" and smaller shall be 600 psi CWP, have cast brass bodies, replaceable reinforced Teflon seats, conventional port, blowout proof stems, chrome plated brass ball, and threaded or solder ends with extended solder cups. Provide extended valve handle to accommodate up to 2” of insulation with non-thermal conductive material, insulation plug, cap and protective sleeve.

Recommended valves:

Threaded:	Solder:
Stockham S-216-BR-RT	Stockham S-216-BR-RS
Worcester 4112 RT	---
Jamesbury II 1100TT	----
Apollo 70-100	Apollo 70-200
Nibco T580-70BR	S580-70BR-R
Inline 334	----

Drain valves, ½” or ¾”, shall be 600 psi CWP, with stainless steel trim, cast bronze body, 2-piece with cap and chain, full port stainless steel ball and stem, RTFE ball seat, threaded or soldered inlet connection, cap rated for 150 psi.

Recommended valve:

Stockham S-285-BR-R-66-HC

C. Gate Valves - 2-1/2" and larger:

Valves 2-1/2" and larger shall be Class 125 iron body, bronze mounted, with body and bonnet conforming to ASTM A-126 Class B cast iron, flanged ends, with Teflon-impregnated packing and two-piece packing gland assembly.

Recommended valves:

Stockham G-623 (OS&Y) RS

Stockham G-612 (NRS)

	OS&Y	NRS
Nibco	F618-0	F639-31
Hammond IR1140		

D. Globe Valves - 2" and smaller:

Valves 2" and smaller shall be of Class 150 with body and union bonnet of ASTM B-62 bronze, copper-silicon alloy stem, brass packing gland, Teflon-impregnated packing and malleable handwheel.

Recommended valves:

Threaded:	Solder:
Stockham B-22 (Teflon Disc)	Stockham B-24 (Teflon Disc)
Stockham B-29 (Stainless trim)	----
Comp. Disc.:	S.S. Trim:
Nibco T-235-Y	Milwaukee 591A

Class 200 valves meeting the above requirements may be used where pressure required:

Stockham B-32 (Teflon disc)

Stockham B-62 (Stainless trim)

E. Globe Valves - 2-1/2" and Larger:

Valves 2-1/2" and larger shall be Class 125 body, bronze mounted, with body and bonnet conforming to ASTM A-126 Class B cast iron, flanged ends, with Teflon - impregnated packing and two-piece packing gland assembly.

Recommended valves:

Stockham G-512 (bronze disc)

Stockham G-514 (Teflon disc)

Hammond IR 116

Nibco F7181B

F. Butterfly Valves - 2-1/2" and Larger:

Valves 2-1/2" and larger shall be high performance, bubble-tight, wafer type body, 200 psi CWP, conforming to ASTM A-126 Class B cast iron, replaceable EPDM sleeve, with ductile nickel-plated disc, 410 stainless steel stem, and EPDM O-ring stem seals. Sizes 2 - 6" shall have lever operators and 8 - 24" shall have gear operators.

Recommended valves:

Stockham LG-512-DS3-B	Lever operated
Stockham LG-522-DS3-B	Gear operated
Lever:	Gear:
Demco NE 150-1215351	NE-150-121359-2097
Norris R1010-13SS-1F	R1010-13SS-2K

Keystone Fig. 239	239
Center Line Series A	Series A
Nibco WD 3110-3	WD 3110-5

Note: In Treated Systems, valves with aluminum bronze disc (ASTM B-148 Alloy 954) and EPT or EPDM sleeve may be preferred.

Recommended valves:

Stockham LG-512-BS3-E	Lever operated
Stockham LG-522-BS3-E	Gear operated

G. Check Valves - 2" and smaller:

Valves 2" and smaller shall be Class 150 with bodies and caps of ASTM B-62 bronze composition and threaded ends. Class 150 valves shall have lift-type Buna-N-disc and union caps, and are to be used in lines with globe valves.

Recommended valves:

Stockham B-322-B

Hammond IB948

Milwaukee 510

For backflow prevention in lines with gate valves, Y-pattern valves with swing-type disc are recommended.

For Class 150 Service, threaded ends:

Stockham B-321

For Class 200 Service, threaded ends:

Stockham B-345

Hammond IB949

Nibco T453-BY

H. Check Valves - 2-1/2" and Larger:

Valves 2" and larger shall be iron body, bronze mounted, with body and cap conforming to ASTM A-126 Class B cast iron, flanged ends, and swing-type disc.

Recommended valves:

Stockham G-931

Hammond IR1124

Nibco F918-B

PART 3 – EXECUTION

3.1 PIPING SYSTEMS

A. All piping to drain to low points. Low points shall be provided with drain valves with hose thread.

B. Valve body construction shall match piping system material.

C. Install isolating fittings between sections of ferrous and non-ferrous pipe or connected equipment.

D. Valves shall be installed with stems above horizontal.

E. Valves shall be installed on all sides of equipment and control valves to allow isolation for repair.

F. Unions shall be provided adjacent to all valves, at equipment connections, and where necessary to facilitate dismantling of the piping system.

3.2 TAGS, CHARTS AND IDENTIFICATION

A. Identify each valve in all systems in accordance with requirements of Section 23 0210.

END OF SECTION 23 0215

SECTION 23 0230

INSULATION & COVERING - HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 23 0200 for HVAC General Provisions

C. Refer to Section 23 0210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes insulation and covering provided on the following piping and equipment:

1. Cold Water Make-Up Piping
2. Hot Water Heating Piping
3. Dual temperature water piping.
4. Hot equipment surfaces.
5. Reusable Valve Covers
6. Insulated Pipe Saddles

B. Insulation shall be installed on the following duct systems:

1. All supply ductwork.
2. All return ductwork.
3. All outside air intake and relief ductwork.

1.3 REFERENCE STANDARDS

A. Refer to Section 23 0200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 23 0210 for a general description of requirements applying to this section.

B. Install insulation in accordance with manufacturer's recommendations.

C. Provide adequate supervision of labor force to assure that all aspects of the specifications are being fulfilled.

1.5 SUBMITTALS

A. Submit shop drawings, installation instructions, and manufacturer's literature of all materials specified in accordance with Section 23 0200.

B. Submit fabrication instructions for pipe fitting and valve insulation.

C. Submit manufacturer's joining recommendations for butt joints and longitudinal seams.

1.6 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 – PRODUCTS

2.1 PIPE INSULATION MATERIAL

A. Fiberglass:

1. Material: Preformed fiberglass bonded with resin to form circular pipe sleeves with factory applied, white all service jacket bonded to reinforced foil vapor barrier jacketing. The jacket shall have factory applied double pressure-sensitive, self-sealing, adhesive closure and vapor sealing of longitudinal joints. Thermal conductivity: 0.24 Btu/Hr./SF/inch at 100 degrees F. Flame spread of 25 and developed smoke of 50 or less.

2. All Valves and Fittings:

   a. Glass fiber insert and pre-molded PVC cover, Johns Manville Corp. "Zeston" and "Hi-Lo Temp Inserts" for fittings. Glass fiber or prefabricated elastomeric foam fittings must fill the entire space within the cover completely.

   b. Factory molded fibrous glass fitting covering for fittings. Coat ends with Fosters 30-36 lagfast adhesive

   c. Mitered sections of pipe covering for valves.

3. Manufacturers: Johns Manville Corp., Certain-Teed, Owens- Corning, Knauf, Armacell.

B. Closed Cell:

1. Material: Black flexible elastomeric foamed closed cell structure insulation 25/50 rated with a flame spread rating of 25 or less and a smoke developed rating of 50 or less with both a moisture seal and a reinforced elastic foam lap seal closure system.

2. Flexible pipe insulation shall be a foamed elastomeric closed cell structure material, with a thermal conductivity of not more than 0.27 Btu/Hr./Sq. Ft./Inch at a mean temperature of 75 degrees F. The insulation shall have an average density of at least 2 pounds per cubic foot, shall be self-extinguishing, and shall have a water vapor transmission rating of not more than 0.1 perms. Between temperature limits of -40 degrees F and plus 220 degrees F, the insulation shall not indicate any deviation from its original state.

3. Specification Compliance:

   ASTM-E-84

   ASTM-C-534 Type I – Tubular, Type II – Sheet.

   ASTM-D-1056, 2B1 – Tubular, Sheet.

   MIL-C-3133B (MIL STD 670B) Grade SBE-3

   MIL-P-15S280J, Form T, Form S.

4. Manufacturers: Armacell, Nomaco, K-Flex.

C. Covering of Pipe Insulation Outdoors:

1. Wrapping: Wrap insulation with embossed 0.016" aluminum jacket.

2. Fastenings: Cover shall be held in place with soft aluminum bands on 12" centers.

3. Valves and Fittings: Weatherproof all valves and fittings.

D. Manufacturers: Johns Manville Corp.., Certain-Teed, Owens- Corning, Knauf.

2.2 DUCT INSULATION

A. Concealed Supply, Return, Relief, and Outside Air Ductwork, and all ductwork connected to energy recovery units: Fiberglass duct wrap bonded with resins, 3/4 pound density, aluminum foil facing reinforced with fiberglass scrim, laminated to Kraft, 2" thick.

1. Thermal Conductivity: 0.27 Btu/Hr./SF/Inch at 75 degrees F. Min. installed "R" value w/25% compression shall be 5.6.

2. Duct wrap shall be cut to stretch-out dimensions as provided in manufacturer's instructions. Remove a 2" piece of insulation from the facing at the end of the piece of insulation to form an overlapping staple and tape flap. Install with facing outside so tape flap overlaps insulation and facing at other end. Insulation shall be tightly butted and not compressed excessively at duct corners. Seams shall be stapled 6" on center with outward clinching staples. All seams, tears, punctures and other penetrations of the insulation facing shall be sealed with foil tape or vapor proof mastic. Where rectangular ducts are 24" in width or greater, duct wrap shall be secured to the bottom of the duct with mechanical fasteners; i.e., stick pins spaced 18" on center.

B. Exposed supply, return, relief, and outside air ductwork, and all ductwork connected to energy recovery units, shall be insulated in finished conditioned spaces, penthouse, mechanical rooms, mezzanine areas, equipment closets, and non-conditioned spaces with 2" thick rigid fiberglass board. Insulation shall be 6 P.C.F. density with a "K" value of 0.25 Btu/Hr./SF/Inch at 75 degrees F. mean temperature and shall be U.L. listed at 25 maximum for flame spread, and 50 maximum for smoke developed. Insulation shall be applied using Graham Pins or Stik-Clips and all seams, edges and breaks shall be sealed with 4" matching tape and sealed with Vicryl CP-10 to match ASJ jacket. Insulation shall be provided with all-service jacket facing.

C. Manufacturers: Johns Manville Corp., Certain-Teed or Owens- Corning, Knauf.

D. Outdoor Installation:

1. Pre-manufactured panel system consisting of four (4) piece interlocking panels.

2. The interlocking panels shall be constructed of Dow Thermax Polyisocyanurate insulation, ASTM D-1622, nominal 2 pcf; water vapor transmission as permeance less than 0.03, per ASTM E-96; water absorption less than 0.3% (24 hours), per ASTM C-209; flexure strength more than 40 psi, per ASTM C-203.

3. Operating temperature range of -100°F to +250°F.

4. Insulation shall be laminated in two (2) layers to provide R-14 at 2" thickness, per ASTM C-236/C-518.

5. The insulation shall be jacketed with 0.032" thick embossed aluminum and sealed with vapor barrier compound. All joints shall interlock to ensure a thermal seal.

6. Panels shall be secured with #10 self-tapping stainless screws with weather seal washers.

7. Manufacturers: Techna-Duc Insulation System as made by P.T.M. Manufacturing, L.L.C., Newark, Delaware.

2.3 REUSABLE VALVE COVERS

A. All valves, strainers, combination valves, etc. in chilled water and heating hot water systems shall be insulated with a factory fabricated removable and reusable cover. (This product shall not be used for pipe and fittings.)

B. Insulation shall be either fiberglass blanket or flexible elastomeric thermal insulation as listed in Paragraph 3.2 of this specification, or prefabricated fitting from the supplier. Flame and smoke spread shall be 25/50 per ASTM 84.

C. Outer jacket shall be made of material equal to Tychem QC, overlap and completely cover the insulation, with seams joined by tabs made from Velcro or fabric straps per manufacturer's standards.

D. Outer jacket shall overlap adjoining sections of pipe insulation, and shall be non-combustible, impermeable to water, and prevent mold, mildew and condensation.

E. Installation shall not require the use of any special hand tools.

F. Manufacturers: Corick Valve Covers, NoSweat Valve Wraps.

2.4 INSULATED PIPE SADDLES

A. Insulation and facing shall each meet 25/50 flame and smoke ratings per ASTM E-84 on a component basis.

B. A section of rigid insulation shall be used at all cold pipe hangers or support locations and shall consist of:

1. A rigid 3.75 PCF phenolic foam pipe insulation designed to support pipe sizes up to and including 6" iron pipe size.

2. A rigid 5 PCF phenolic foam pipe insulation designed to support pipe sizes from 8" to 30" iron pipe size.

3. For all hot pipe hanger or support locations, the insert material shall be either rigid calcium silicate per ASTM C303 or perlite silicate per ASTM C303 with all service jacket and laminated to a steel support saddle.

C. The insulation jacket shall contain a vapor retarding material to provide low moisture vapor permeability and resistance to mold, mildew and fungus growth.

D. The insulation shall be free of any CFC or HCFC materials.

E. The insulation shall have a minimum K-factor of 0.13 at 75 deg. F mean temperature, and self-sealing lap joint with high performance acrylic pressure sensitive adhesive tape.

F. Integral insulation saddle shall be made of G-90 carbon steel, with full 180 deg. Coverage, flared edges to protect the vapor barrier jacket and insulation, and short rib surface to center the saddle inside the hanger and prevent movement.

G. Preformed insulation shall extend beyond the saddle by a minimum of 1-1/2" to accommodate a tape joint seal at the butt edges of adjoining insulation sections.

H. Minimum product dimensions shall be as follows:

Nominal pipe size (inches)	Insulation density (PCF)	Insulation length (inches)	Saddle length (inches)	Saddle gauge
½ - 3-1/2	3.75	9	6	20
4 – 6	3.75	12	9	18
8 – 18	5.0	18	12	16
20 – 30	5.0	24	18	14

I. Manufacturer: Tru-Balance insulated saddles as made by Buckaroos, Inc.

PART 3 – EXECUTION

3.1 INSTALLATION – GENERAL

A. Do not install until systems have been tested and meet requirements.

B. Heavy work which may damage insulation shall have been completed in the vicinity of the insulation work.

C. Provide non-compressible insulation saddles at all piping hanger locations, and at all piping hanger locations where piping is insulated with flexible closed cell insulation.

Option: Provide insulation coupling system as made by Klo-Shure Co.

D. All installations shall be made by skilled craftsmen regularly engaged in this type of work.

E. Insulation shall be continuous thru-wall, ceiling and floors.

F. Metal shields, 16 gauge galvanized, shall be installed between hangers and pipe insulation.

G. Pipe, ductwork and equipment shall be clean and dry prior to insulating.

H. Install all insulation per manufacturer's instructions.

I. To avoid undue compression of insulation, provide solid core inserts at all supports as recommended by the insulation manufacturer. Provide insulation shields between the insulation jacket and the hanger.

J. Apply vapor proof mastic as recommended by the insulation manufacturer on all longitudinal and butt joints of sectional pipe insulation. Apply similar mastic to the end of every third length of sectional pipe insulation on all chilled water and dual temperature pipe insulation to prevent the migration of condensation that might occur.

K. For pre-manufactured expansion loops, provide a second layer of insulation with air gap to maintain loop flexibility. Install in accordance with the loop manufacturer's written instructions.

3.2 PIPE INSULATION - TYPES & THICKNESSES

A. Provide fiberglass insulation of thickness specified on:

1. Cold Water Make-Up: 1" for piping 2" and below.
2. Heating Hot Water: (Up to 200°F)

   1-1/2" for piping 1-1/2" and below

   2" for pipes 2" and over.
3. Dual Temperature Water:

   1-1/2" for piping 1-1/2" and below.

   2" for piping 2" and larger.

B. Provide flexible closed cell insulation of thickness specified on:

1. Hot expansion tanks. 3/4" thickness
2. 1" thickness for all water piping within terminal unit cabinets.

   1" thickness for chilled water piping 1-1/2" and below.

   1" thickness for dual temperature piping 1-1/2" and below.

3. ½" thickness for condensate drain lines.

3.3 PIPE COVERING (FOAMED PLASTIC TYPE)

A. All joints and seams shall be sealed with a compatible adhesive. Approved adhesives are as follows:

Armstrong World Industries No. 520

Benjamin Foster Company No. 85-75 up to 200 degrees F.

Contractor may use Armstrong Self-Seal Armaflex 2000 insulation in lieu of the above wherever 1/2" is specified.

B. Fitting covers shall be fabricated from the foamed plastic pipe insulation or from sheet insulation of the identical material. The fabrication shall be in accordance with manufacturer's instructions, and all seams mitered joints shall be joined using the adhesives described hereinbefore.

C. Pipe insulation in concealed spaces shall require no finish coatings.

D. Pipe insulation in all other areas shall receive two coats of finish of color selected by Architect. Approved finishes are as follows:

Armstrong World Industries WB Armaflex Finish

3.4 INTERIOR PIPE COVERING

A. Provide premolded PVC cover on all interior insulated piping exposed in finished spaces. Orient seams up in overhead piping and toward the wall in vertical runs.

B. Provide factory molded fitting covering for fittings and accessories, sealed and held in place by manufacturer's recommended sealing system.

C. Provide mitered sections of covering for valves.

3.6 INSULATED PIPE SADDLES

A. Insulated pipe saddles shall be installed at all hangers, rollers or supports in accordance with manufacturer's written instructions.

B. All piping shall be clean and free of oil, rust and moisture prior to and during support installation.

C. All insulated saddles and accessories shall be stored in a dry area protected from weather before and during installation

D. Seal adjoining butt edges of pipe insulation with approved mastic and tape to insure continuity of the insulation jacket and vapor barrier, especially on cold piping system installations.

END OF SECTION 23 0230

SECTION 23 0300

VIBRATION AND SOUND ISOLATION – HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 23 0200 for HVAC General Provisions

C. Refer to Section 23 0210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes providing the following vibration and sound isolation material on items furnished and installed under HVAC work:

1. Pump-mounted inertia pads
2. Piping, Inline Pumps
3. Fans and AHU's
4. Suspended Fans, H&V Units
5. Rooftop AHU's

1.3 REFERENCE STANDARDS

A. Refer to Section 23 0200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 23 0210 for a general description of requirements applying to this section.

1.5 SUBMITTALS

A. Submit shop drawings, installation instructions, and manufacturer's literature of all materials specified in accordance with Section 23 0200.

B. Submit the following:

1. Shop drawings
2. Product data

1.6 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 – PRODUCTS

2.1 GENERAL

A. All vibration control apparatus shall be furnished by a single recognized manufacturer. The manufacturer shall submit to the Architect/Engineer evidence affirming that he has been a supplier of vibration control devices of the type required for the past five years.

B. The vibration control apparatus manufacturer shall supervise, inspect, measure, and approve the installation and shall submit a report to the Architect/Engineer substantiating that all the equipment has been adequately isolated.

C. Any requests for changes in the specifications must be submitted in writing in time for review and approval through a written addendum to the specifications prior to bid closing.

D. Unless otherwise indicated or specified, all equipment mounted on vibration isolator bases shall have a minimum operating clearance of 1 inch between the base and the floor or housekeeping and beneath. Clearance space shall be checked to insure that no scrap, rubbish, hardware, etc., has been left to possibly short circuit isolated base.

E. In connecting isolated HVAC equipment to rest of system, care must be exercised to insure proper installation.

1. Equipment connected to water piping shall be erected on isolators or isolated foundations to correct operating height prior to making piping connections to avoid misalignment problems. To facilitate this, equipment shall be blocked-up with temporary shims to final operating height. When full load is assembled and water is in system, isolators shall then be adjusted to take up load just enough to allow removal of shims.

2. Air handling equipment such as centrifugal fans shall be erected on isolators and leveled with fan operating before flexible duct connection is made. Insure that duct position is in proper alignment and providing proper clearance in proportion to flexible duct connector length. When fan is shut off, misalignment with ductwork is allowable providing it does not strain or damage flexible duct connector. In cases of high static pressure, fans requiring position stabilizers are to be adjusted when fan is operating to achieve the results as described above with isolator adjustment.

F. Vibration isolator sizes and location shall be determined by the vibration control products manufacturer or as specified herein.

G. Model numbers of Amber/Booth Co., are given for identification. Products of specified manufacturers will be acceptable, provided they comply with all of the requirements of this specification.

2.2 ISOLATOR TYPES

A. Pump Mounted Inertia Pads:

1. Frame to be structural steel with built-in height saving bracket for recessing into a CPF concrete inertia block for side access.

2. Spring to be adjustable, free-standing, open-spring mounting with combination leveling bolt and equipment fastening bolt. The spring shall be rigidly attached to the spring mounting baseplate and compression plate. The isolator shall be designed for a minimum Kx/Ky (Horizontal-to-Vertical spring rate) of 1.0. A neoprene pad having a minimum thickness of 1/4" shall be bonded to the baseplate. Amber/Booth Type CPF with RSW-1.

B. Piping in Mechanical Room, In-Line Pumps:

1. Type PBSR: for first two hangers in horizontal piping adjacent to isolated equipment and for all hangers on 8" and larger pipe, except the first two hanger points adjacent to riser shall be Type BS.

2. Type BSR for remaining hangers in horizontal piping.

3. Type SW for pipe risers. Isolator base plates shall be provided with holes for bolting and isolation grommets.

4. Type SW for floor supports except Type CT for first floor support adjacent to equipment isolated on CT isolators.

C. Fans and Air Handling Units:

1. For slab on-grade installations, provide:

   a. Type NRC = Pads, Washers and Bushings: Pads shall be felt, cork, neoprene waffle, neoprene and cork sandwich, neoprene and fiberglass, neoprene and steel waffle, or reinforced duct and neoprene. Washers and bushings shall be reinforced duct and neoprene. Size pads for a maximum load of 50 pounds per square inch.

2. For floors above-grade, up to 40 ft. span, provide:

   a. Type SW = Spring Isolators: Shall be free-standing, laterally stable and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter-to-operating spring height of 1.0 and an additional travel to solid equal to 50 percent of rated deflection.

   b. Type PBSRA - Combination Neoprene and Spring: Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.

   c. Thrust Restraints: Restraints shall provide a spring element contained in a steel frame with neoprene pads at each end attachment. Restraints shall have factory preset thrust and be field adjustable to allow 1/4" maximum movement when the fan starts and stops. Restraint assemblies shall include rods, angle brackets and other hardware for field installation.

D. Suspended Fans and H&V Units

1. For floors above-grade, up to 40 ft. span, provide:

   a. Type SW = Spring Isolators: Shall be free-standing, laterally stable and include acoustical friction pads and leveling bolts. Isolators shall have a minimum ratio of spring diameter-to-operating spring height of 1.0 and an additional travel to solid equal to 50 percent of rated deflection.

   b. Type PBSRA - Combination Neoprene and Spring: Vibration hanger shall contain a spring and double deflection neoprene element in series. Spring shall have a diameter not less than 0.8 of compressed operating spring height. Spring shall have a minimum additional travel of 50 percent between design height and solid height. Spring shall permit a 15 degree angular misalignment without rubbing on hanger box.

   c. Thrust Restraints: Restraints shall provide a spring element contained in a steel frame with neoprene pads at each end attachment. Restraints shall have factory preset thrust and be field adjustable to allow 1/4" maximum movement when the fan starts and stops. Restraint assemblies shall include rods, angle brackets and other hardware for field installation.

E. Rooftop AHU's:

1. Type RTIR: Provide an extruded aluminum rail base for rooftop air conditioning units consisting of a pair of weatherproofed aluminum rails for fastening to equipment and to roof curb incorporating wind restraints and a continuous air and water seal which is protected from accidental puncture and direct sunlight by an aluminum weather shield. Rails shall incorporate non-adjustable Type SW spring isolators properly spaced around perimeter and sized for 1" deflection. To prevent leaks, rails shall be factory assembled (to the limits of freight carriers) and shipped as a one- piece unit.

F. Ductwork and Equipment Lagging:

1. The barrier shall be constructed of 0.10" thick barium sulphate loaded limp vinyl sheet bonded to a thin layer of reinforced aluminum foil on one side.
2. The barrier shall have a nominal density of 1 psf and shall have a minimum STC rating of 28.
3. The barrier shall exhibit minimum flammability ratings of 0.0 seconds for flame out and after glow and 0.2 inches for char length when tested in accordance with Federal Test Standard No. 191-5903.
4. The barrier shall have a minimum thermal conductivity "K" value of 0.29 and a rated service temperature range of 40°F to 220°F. When tested for Surface Burning Characteristics per ASTM E84, the barrier will have a flame spread index of no more than 10 and a smoke development index of no more than 40.
5. The decoupling layer shall be a combination of 1", 2" fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together in a matrix of 4" diamond stitch pattern which encapsulates the glass fibers. The barrier shall be Type KNM-100-ALQ-1 or 2 and the decoupling layer shall be type KFA by Kinetics. The composite material shall be fabricated to include a nominal 6" wide barrier overlap tab extending beyond the quilted fiberglass to facilitate a leak-tight seal around field joints. Nominal barrier width 54", nominal decoupler width 48".
6. Sound Transmission Loss: Tested as a free hanging barrier (ASTM E-90-90)

	Frequency, Hz						
Product	125	250	500	1000	2000	4000	STC
KNM 100ALQ-1	13	16	24	33	43	49	28
KNM 100ALQ-2	11	16	26	35	44	49	28

G. Manufacturers: Amber/Booth, Kinetics Noise Control, Mason Industries, Vibration Mounting & Controls, Vibration Eliminator, Inc., Vibro-Acoustics.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's specifications and instructions.

1. No metal-to-metal contact will be permitted between fixed and floating parts.
2. Connections to Equipment: Allow for deflections equal to or greater than equipment deflections. Electrical, drain, piping connections, and other items made to rotating or reciprocating equipment (pumps, compressors, etc.) which rests on vibration isolators, shall be isolated from building structure for first three hangers or supports.
3. Common Foundation: Mount each electric motor on same foundation as driven machine. Hold driving motor and driven machine in positive rigid alignment with provision for adjusting motor alignment and belt tension. Bases shall be level throughout length and width. Provide shims to facilitate pipe connections, leveling and bolting.
4. Provide heat shields where elastomers are subject to high temperatures.

5. Extend bases for pipe elbow supports at discharge and suction connections at pumps. Pipe elbow supports shall not short circuit pump vibration to structure.
6. Non-rotating equipment such as heat exchangers and convertors shall be mounted on isolation units having the same static deflection as the isolation hangers or support of the pipe connected to the equipment.
7. Ensure that the outer surface of the equipment or duct is clean and free of dust, dirt or similar foreign matter. If desired, the outside surface can be painted with a rust-resistant paint in order to minimize potential corrosion.
   a. Field cut and apply the insulation decoupler to the outside of the duct. Obtain a uniform thickness by butting all seams together (do not overlap). At elbows or similar transitions, field measure and miter cut the insulation to fit. Ensure that the insulation is not compressed by the fastener used, if any.
   b. Wrap the noise barrier around the equipment housing or insulation-wrapped duct. At all seams, overlap the barrier by a minimum of 2" and adhere using adhesive. Alternately, the barrier can be butted together at joints with the seam covered by a 2" (50 mm) wide cut piece of the barrier material. This strip is then adhered to the barrier on either side of the seam using adhesive.
   c. If desired, metal or nylon bands can be wrapped around the outside of the barrier to guard against the potential of adhesive failure. If used, this banding should be placed on either side of all radial seams in addition to the midpoint on longer sections. Ensure that the banding is snug only and does not result in compression of the insulation decoupler beneath.
   d. In lieu of banding, insulation "stick pins" can be used to reinforce the seams in the noise barrier. Ensure that the pin does not compress the insulation or barrier material beneath.

B. Inspection and Adjustments: Check for vibration and noise transmission through connections, piping, ductwork, foundations, and walls. Adjust, repair or replace isolators as required to reduce vibration and noise transmissions to specified levels.

END OF SECTION 23 0300

SECTION 23 0400

HEATING GENERATION EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 23 0200 for HVAC General Provisions.

C. Refer to Section 23 0210 for HVAC Basic Materials and Methods.

D. Refer to Section 23 0230 for Insulation and Covering – HVAC

1.2 DESCRIPTION OF WORK

A. This Section includes labor, material, and equipment necessary to provide a complete boiler system as specified herein and shown on the drawings:

1. Boilers - General
2. High Efficiency Water Boilers

B. Refer to other Division 23 sections for related work.

1.3 REFERENCE STANDARDS

A. Refer to Section 23 0200 for a general description of requirements applying to this Section.

B. See specifications in this Section for specific compliance with I=B=R, NFPA, UL, ASME, etc.

C. Underwriters Laboratories:

1. UL 795 – Commercial-Industrial Gas Heating Equipment

D. American Society of mechanical Engineers:

1. ASME Section IV – Boiler and Pressure Vessel Code – Heating Boilers.
2. ASME “H” stamp for 160 PSI working pressure

E. Hydronics Institute Boiler Testing Standards:

1. BTS-2000 – Method to Determine Efficiency of Commercial Space Heating Boilers.

F. American National Standards Institute

1. X21.13 Test standard

G. CSDI/Factory Mutual

1.4 QUALITY ASSURANCE

A. Refer to Section 23 0210 for a general description of requirements applying to this section.

B. Quality Assurance:

1. Manufacturers: Firms regularly engaged in manufacture of boilers, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
2. Regulatory Requirements:

a. I=B=R Compliance: Provide boilers that have been tested and rated in accordance with Institute of Boiler and Radiator Manufacturers (I=B=R) "Testing and Rating Standard for Cast Iron and Steel Heating Boilers", and bear I=B=R emblem on nameplate affixed to boiler.

b. NFPA Compliance: Install boilers in accordance with National Fire Protection Association (NFPA) Code 54 "National Fuel Gas Code".

c. NFPA 211 Compliance: Heating equipment burning gas, solid or liquid fuels, Section 60.

d. Underwriter's Laboratories, Inc., (U.L.) file MA 7991 for storage of flammable liquids.

e. ASME, CSD-1

f. ASHRAE 90.1 Standard

g. AHRI BTS-2000 Standard – Department of Energy

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 23 0200.

B. Submit the following:

1. Shop Drawings
2. Product Data
3. Evidence of specified code or other compliance.

1.6 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS. In addition, the following special guarantee applies:

1. Start-up and one year of factory service on boilers. One year to commence after start-up.
2. Complete heat exchanger assembly shall carry a ten (10) year warranty.
3. All other parts shall have a 1-year limited warranty.

PART 2 – PRODUCTS

2.1 BOILER – CONDENSING TYPE

A. Boiler shall operate at a minimum of 96.2% thermal efficiency at full fire as registered with AHRI. The registered combustion efficiency must be equal or greater than the registered thermal efficiency. All models shall operate up to 98% thermal efficiency with return water temperatures at 70°F or below at 20°F temperature rise.

B. Boiler shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. Two burner/flame observation ports shall be provided. The single burner shall be premix design constructed of high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates.

C. Boiler shall be supplied with two gas valves designed with negative pressure regulation and be equipped with a pulse width modulation blower system, to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The Boiler shall operate in a safe condition with gas supply pressures as low as 4 inches of water column. The burner flame shall be ignited by direct spark ignition with flame monitoring via a flame sensor.

D. Boiler shall utilize a 24 VAC control circuit and components. The control system shall have a display for boiler set-up, boiler status, and boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket.

E. Boiler shall be equipped with a temperature/pressure gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 50 psi (standard); outlet water temperature sensor (dual thermistor); return water temperature sensor; outdoor air sensor, flue temperature sensor (dual thermistor); high and low gas pressure switches, low water cut off with manual reset, blocked drain switch and condensate trap for the heat exchanger condensate drain.

F. Boiler shall feature the "SMART TOUCH™" control which is standard and factory installed with an 8" liquid crystal touch screen display, password security, outdoor air reset, pump delay with freeze protection, pump exercise, ramp delay featuring six steps, domestic hot water prioritization with limiting capabilities and PC port connection. A secondary control that is field mounted outside or inside the appliance is not acceptable.

G. Boiler shall have alarm contacts for any failure, runtime contacts and data logging of runtime at given modulation rates, ignition attempts and ignition failures.

H. Boiler shall have a built-in "Cascade" to sequence and rotate while maintaining modulation of up to eight boilers of different BTU inputs without utilization of an external controller. The internal "Cascade" function shall be capable of lead-lag, efficiency optimization, front-end loading, and rotation of lead boiler every 24 hours.

I. Boiler shall be capable of controllingan isolation valve (valve shall be offered by manufacturer) during heating operation and rotation of open valves in standby operation for full flow applications. The control must be equipped with standard BACnet MSTP/Modbus communication protocol with a minimum 55 readable points.

J. Boiler shall have an optional gateway device which will allow integration with LON or BACnet (IP) protocols.

K. The "SMART TOUCH™" control shall increase fan speed to boost flame signal when a weak flame signal is detected during normal operation. A 0-10 VDC output signal shall control a variable speed boiler pump (pump to be offered by manufacturer) to keep a fixed delta t across the boiler regardless of the modulation rate.

L. Boiler shall have the capacity to receive a 0-10 VDC input signal from a variable speed system pump to anticipate changes in system heat load in order to prevent flow related issues and erratic temperature cycling.

M. Boiler shall be equipped with two thermal strips for electrical connection. A low voltage connection board with 30 data points for safety and operating controls, i.e. Alarm Contacts, Runtime Contacts, Louver Proving Switch, Tank Thermostat, Remote Enable/Disable, System Supply Sensor, Outdoor Sensor, Tank Sensor, Modbus Building Management System signal and Cascade control circuit. A high voltage terminal strip shall be provided for Supply voltage. Supply voltage shall be 120 volt/60 hertz/single phase. The boiler may be factory trimmed for optional supply voltages, i.e. 208 Volt/60 hertz/3 phase, 480 volt/60 hertz/3 phase and 600 volt/60 hertz/3 phase. The high voltage terminal strip plus integral relays are provided for independent pumnp control of the system pump, the boiler pump, and the domestic hot water pump.

N. Construction

1. The boiler shall have a fully welded 316L stainless steel, fire tube heat exchanger. There shall be a single pressure vessel. Fire tube shall be of the Wave Fire Tube design and capable of transferring 16,000 to 20,000 BTU's per tube. A liquid impact die shall be used to form the Wave Fire Tube. There shall be no banding material, bolts, gaskets or "O" rings in the heat exchanger construction.

The Wave Fire Tube shall be robotically welded to the tube sheets. The heat exchanger shall be designed for a single-pass water flow to limit water side pressure drop. Pressure drop shall be no greater than 3.2 psi at 180 gpm. The condensate collection basin shall be constructed of welded 316L stainless steel.

O. Boilers Commissioning:

1. The boiler shall be started up and commissioned by a Lochinvar Factory Authorized Start-up Technician.

P. The boiler shall be installed and vented with a Common Venting System as specified by Precision Vent.

Q. The boiler shall be provided with an 8" common vent damper by Lochinvar DRH 3001 – Field installed.

R. Guarantee: The boiler shall be provided with start-up by factory trained personnel and a full one year factory service to begin at start-up. The boiler shall be warranted for a minimum of twenty (20) years against thermal shock damage, non-pro-rated.

S. Manufacturers: Lochinvar Corp.- "CREST" Series.

END OF SECTION 23 0400

SECTION 23 0410

HEATING GENERATION AUXILIARY EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the Contract, including the Conditions of the Contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 23 0200 for HVAC General Provisions.

C. Refer to Section 23 0210 for HVAC Basic Materials and Methods.

D. Refer to Section 23 0400 for Heating Generation Equipment.

1.2 DESCRIPTION OF WORK

A. This Section includes labor, material, equipment necessary for a complete boiler system as specified and shown on the drawings:

1. Special Gas Vent Pipe & Fittings

B. Provisions for fuel oil storage tanks, pads, piping and pump.

C. Provision for boiler stack and breeching, or vent and combustion air piping.

D. Refer to other Division 23 sections for related work.

1.3 REFERENCE STANDARDS

A. Refer to Section 23 0200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 23 0210 for a general description of requirements applying to this section.

B. Quality Assurance:

1. Manufacturers: Firms regularly engaged in manufacture of equipment types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.

2. Regulatory Requirements:

a. NFPA Compliance: Install gas-fired cast-iron boilers in accordance with National Fire Protection Association (NFPA) Code 54 "National Fuel Gas Code".

b. NFPA 211 Compliance: Heating equipment burning gas, solid or liquid fuels, Section 60.

c. Underwriter's Laboratories, Inc., (U.L.) file MA 7991 for storage of flammable liquids.

d. NFPA 30 and 31 compliance for storage of flammable liquids

e. Licensed and certified installer for underground fuel oil piping and aboveground tanks.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 23 0200.

B. Submit the following:

1. Shop Drawings

2. Product Data

3. Evidence of specified code or other compliance.

1.6 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, GENERAL REQUIREMENTS

PART 2 – PRODUCTS

2.1 SPECIAL GAS VENT PIPE & FITTINGS

For Category II or IV Appliances and Condensing High Efficiency Appliances requiring a listed UL-1738 Special Gas Vent. The installation of six (6) Crest FBN2001 Boilers on this project with the venting configured as shown on the drawings shall be known as an Engineered Vent System.

A. Double wall prefabricated system listed to UL-1738 Standard for Venting Systems for GasBurning Appliances, Categories II and IV made with AL29-4C stainless, or equivalent UL-1738 approved stainless steel inner liner, 1" insulating air space, and 400 series stainless steel outer jacket. Vent shall be designed for maximum 550°F and positive pressue of 15" W.C.

B. Complete with: factory appliance flue connector, boot tees, drain caps or inline drains, stack supports, roof flashings, and termination. All items sopecifically required by Appliance and Gas Vent manufacturers installation instructions.

C. Submit CAD drawings with Draft Calculations showing that the exhaust vent system is in complete compliance with both the Appliance and Vent manufacturers' installation instructions.

D. Manufacturers: Heat-Fab CI PLUS, Jeremias DWKL, M&G Duravent FasNSeal, Security Chimneys SSD, or Z-FLEX Z-Vent.

END OF SECTION 23 0410

SECTION 23 0450

REFRIGERATION EQUIPMENT – HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 23 0200 for HVAC General Provisions

C. Refer to Section 23 0210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes labor, material, equipment and supervision to for the following:

1. Ductless Split System Heat Pump Units

B. Provide complete refrigeration system including chillers, cooling towers, underground pre-insulated pre-fabricated piping, aboveground piping and all required accessories.

1.3 REFERENCE STANDARDS

A. Refer to Section 23 0200 for a general description of requirements applying to this section.

B. Comply with applicable provisions of:

1. International Mechanical Code
2. ASME Codes for Pressure Vessels
3. A.R.I. Capacity Ratings
4. NFPA Pamphlets
5. ASHRAE Standard 15
6. ASHRAE Standard 90.1, Section 6, Table 6.8.1A thru J, minimum equipment efficiency.

1.4 QUALITY ASSURANCE

A. Refer to Section 23 0210 for a general description of requirements applying to this Section.

B. Whenever a variable frequency PWM drive is installed to control an AC motor, a maintenance-free, circumferential, conductive micro fiber shaft grounding ring shall be installed on the AC motor drive end to discharge shaft currents to ground. Recommended part: AEGIS SGR™ Bearing Protection Ring, as made by Electro Static Technology. Install in accordance with the manufacturer's written instructions.

C. Verification of Fluid Cooler Performance:

1. Manufacturer shall have a thermal performance testing program for water cooling towers certified by the Cooling Technology Institute (CTI) in accordance with CTI Specification Standard STD-201. Manufacturer's performance guarantees or performance bonds shall also be accepted.
2. Unit Sound Performance ratings shall tested and certified according to CTI ATC-128 standard. Sound ratings shall not exceed specified ratings.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 23 0200.

B. Submit the following:

1. Shop drawings and product data for all equipment in this section.
2. 1/4" = 1'-0" scale layout of all equipment in Mechanical Room.

1.6 SUBSTITUTIONS

A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements. In addition, the following special guarantee applies:

1. Manufacturer shall guarantee all refrigeration equipment including parts and labor, for five (5) years from start-up.

PART 2 – PRODUCTS

2.1 DUCTLESS SPLIT SYSTEM HEAT PUMP UNIT

A. Air conditioning system shall be a ductless split system heat pump. The system shall consist of a compact ceiling-mounted packaged evaporator section and matching outdoor air-cooled condensing unit. The units shall be listed by and bear the ETL label. All wiring should be in accordance with the National Electrical Code (N.E.C.). The units shall be rated in accordance with ARI Standard 240 and bear the ARI label. A full charge of refrigerant for 100 feet of refrigerant tubing shall be provided in the condensing unit. A dry nitrogen holding charge shall be provided in the evaporator. System SEER shall meet or exceed 1992 Federal Standards.

B. The indoor unit shall be factory assembled and wired. The casing fascia shall have a white or gray finish. The evaporator fan shall be an assembly with line flow fans direct driven by a single motor. The supply fan motor shall be multi-speed, permanent-split capacitor type with thermal overload protection and sealed, lifetime bearing. The fan shall be backward curved, centrifugal design, statically and dynamically balanced and run on permanently lubricated bearings. An adjustable guide vane shall be provided with the ability to change the air flow from horizontal to vertical. A motorized air sweep flow louver shall provide an automatic change in air flow by directing the air from side to side for uniform air distribution. Return air shall be filtered by means of an easily removable washable filter.

C. The evaporator coil shall be nonferrous construction with smooth plate fins bonded to copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phoscopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan and drain shall be provided under the coil. The unit shall be furnished with integral condensate pump with 18” minimum lift, factory mounted and wired.

D. The unit shall be constructed from galvanized steel that is insulated internally and externally with fire-resistant acoustic insulation.

E. The control system shall be microprocessor based. The wall-mounted remote control enclosure shall include an LCD display providing a continuous display of operating status and condition. An keypad for setpoint/program control, unit ON/OFF, and fan speed shall be located below the display.

1. The auto restart feature shall automatically restart after a power failure.
2. The control shall have temperature control setpoint for cooling function with a minimum 2 deg. F differential. The temperature control setpoint range shall be 60 deg. F to 85 deg. F.
3. The LCD display shall provide an ON/OFF indication, fan speed indication, operating mode indication (cooling, dehumidifying) and current day, time, temperature and humidity (if applicable) indication.

F. Direct Expansion System Components:

1. The evaporative coil shall be constructed of copper tubes and aluminum fins. The coil shall be provided with a drain pan.
2. The refrigeration system shall consist of a hermetic compressor, pressure safety switches, externally equalized expansion valve, and a refrigerant sight glass and moisture indicator.
3. Low ambient control will allow cooling to 0 deg. F outdoor temperature.

G. Remote Air-Cooled Condenser: The condenser coil shall be constructed of copper tubes and aluminum fins, and a direct-drive centrifugal fan. No piping, brazing, dehydration or charging shall be required. Condenser electrical connection shall be by a factory wired plug. Fan shall be sized to provide full rated cooling capacity at 95 deg. F entering air. Provide wire guards on condenser coil and fan discharge.

H. Features:

1. Branch duct knockouts on the sides of the chassis for remote discharge of supply air.
2. Fresh air inlet knockout for connection of ventilation air directly into the unit without the need for an inline booster fan. If the length of ductwork exceeds ten feet, provide a booster fan as scheduled on the drawings.
3. Condensate system shall contain a float switch to automatically shut down the cooling operation if the condensate level reaches an overflow condition.
4. Unit-mounted and wired electric backup heat with manual and automatic thermal cutout switches, for use on heat pump models.

I. Factory installed controls shall include connections for 24-volt, wall-mounted thermostat, control board featuring anti-short cycle timer, 60 second post purge fan relay, on-board 30 AMP electric heat relay, and relays and connectors for condensing unit control. Provide wall-mounted solid state thermostat for field mounting and wiring to the indoor unit; the thermostat shall be capable of one-stage cooling; one-stage cooling, one-stage heating with manual changeover; one-stage cooling, two-stage heating with heat pump operation for the first stage of heat, as scheduled on the drawings.

J. Manufacturers: Airdale, Carrier, Daikin McQuay, EMI, LG HVAC, Mitsubishi Electric, Panasonic, Sanyo Air Conditioning Products.

1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.

PART 3 – EXECUTION

3.1 REFRIGERATION EQUIPMENT

A. All equipment to be installed in accordance with manufacturer's recommendations.

3.2 DUCTLESS SPLIT SYSTEMS

A. Install packaged and split system units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

B. Electrical Wiring: Install electrical devices furnished by manufacturer but not specified to be factory mounted.

1. Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements. Do not proceed with equipment start-up until wiring installation is acceptable.

3.3 FIELD QUALITY CONTROL

A. Start-up all units in accordance with manufacturer's start-up instructions. Replace damaged or malfunctioning controls and equipment.

END OF SECTION 23 0450

SECTION 23 0500

PIPING SYSTEMS & ACCESSORIES - HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 23 0200 for HVAC General Provisions

C. Refer to Section 23 0210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes the following equipment:

1. In-Line Circulator Pumps
2. Base-Mounted End Suction Pumps
3. Suction Diffusers
4. Compression tanks (Horizontal)
5. Diaphragm-Type Expansion Tanks (Vertical or Horizontal)
6. Air Separators
7. Solids Separator
8. Water Feeders
9. Relief Valve (Water Systems)
10. Balancing Valves
11. Combination Valve Package for Pumps

1.3 REFERENCE STANDARDS

A. Refer to Section 23 0200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 23 0210 for a general description of requirements applying to this Section.

B. Whenever a variable frequency PWM drive is installed to control an AC motor, a maintenance-free, circumferential, conductive micro fiber shaft grounding ring shall be installed on the AC motor drive end to discharge shaft currents to ground. Recommended part: AEGIS SGR™ Bearing Protection Ring, as made by Electro Static Technology. Install in accordance with the manufacturer's written instructions.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 230200.

B. Submit the following:

1. Shop Drawings
2. Manufacturers Product Data

3. Test Reports on Piping System Tests

1.6 SUBSTITUTIONS

A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 – PRODUCTS

2.1 PUMPS

A. In-Line Wet Rotor Pumps.

1. Pumps shall be Taco Model Viridian (VR) Series. The pumps shall be single stage, canned-rotor type, in-line design. The capacities and characteristics shall be as called for in the plans/schedules.
2. Pump casing shall be constructed of EN-GJL-250 or ASTM-A 48 Class 35 cast iron. The pump casing/volute shall be rated for 175 psi working pressure for all jobs. The pump flanges shall be matched to suit the working pressure of the piping components on the job, with ANSI Class 125 flanges.
3. All casings shall be flanged connections.
4. The impeller and shall be Class 304 stainless steel.
5. The pump and motor form an integral unit without a mechanical seal. The bearings are lubricated by the pumped liquid. No pertroleum lubricated bearings will be accepted.
6. The pumps shall be able to operate as single or parallel variable speed pumps, where the speed is regulated by an on-board electronic device. The onboard electronics shall allow these pumps to run in parallel, standby or alternating modes.
7. The commissioning and set up of the pump shall be accessed through a wen interface (data exchange) and use HTML 1.1 web language. The pump shall provide a port for a RJ-45 cable connection.
8. The electronics shall provide constant pressure control (Δp-c), variable differential pressure control (Δp-v) as the factory default, proportional pressure control, constant curve duty (uncontrolled pump), RPM regulation and power limitation control.
9. The pump electronics shall come standard with 2 external digital inputs and 1 external digital output to be available for additional mechanical room control.
10. The wiring/electronics enclosure shall be class 2, IP44.
11. Pumps should meet UL 778, 1004-1, 508C, CAN/CSA C22.2 #108, #110, #107.1, EMC (89/366 ECC): EN6100, LVD (73/23/EC): EN 60335-1, EN 60335-2-51, and machine safety (98/37/EC): EN ISO 12100.
12. The pumps shall be electronically protected, be rated for continuous duty and have a built-in

startup circuit. The pump electronics shall provide overcurrent, line surge and current limit protection, thermal monitoring, heat sink status, and over temperature protection.

13. The pump shall be4 capable of being monitored 24/7 via integrated internet link.

14. The pump must be driven by an electrically commutated electrical motor (ECM) with permanent magnet rotor. The rotor magnets shall by time stable, non-toxic ceramic magnets (Sr-Fe). The electronicall commuted electricl motor shall be driven by a frequency converter with an integrated PFC filter.

2.2 BASE-MOUNTED END SUCTION PUMPS

A. Provide frame-mounted end suction pumps where indicated, and of capacities and having characteristics as scheduled.

B. Horizontal mount, single stage, flexible coupling, base-mounted, designed for 175 psi working pressure.

C. Cast iron casing 125 psi ANSI flanges, tappings for gauge and drain connections.

D. Steel shaft with replaceable shaft sleeve, regreasable ball bearings and mechanical seals with carbon seal ring and ceramic seat.

E. Non-overloading motor at any point on pump curve, open, drip-proof, ball bearings, 15,000 hours bearing life, with lifting lug on top of motor.

F. Provide open drip-proof motor with regreasable ball bearings.

G. Enclosed type impeller hydraulically and dynamically balanced, keyed to shaft and secured with locking screw.

H. Structural steel baseplate with welded cross members, and open grouting area.

I. Flexible coupling capable of absorbing torsional vibration, equipped with coupling guard.

J. Manufacturers: Subject to compliance with requirements, provide pumps of one of the following:

Armstrong Pumps

Bell & Gossett

Aurora

Ingersoll Rand

Peerless

Patterson

Paco

Taco

2.3 SUCTION DIFFUSERS

A. Provide at each base-mounted pump, a suction diffuser of size required for pump connection. Units shall consist of angle type body with straightening vanes and combination diffuser-strainer-orifice cylinder with 3/16" diameter openings for pump protection. A permanent magnet shall be located within the flow stream and shall be removable for cleaning. The orifice cylinder shall be equipped with a disposable fine mesh strainer which shall be removed after system start-up. Orifice cylinder shall be designed to withstand pressure differential equal to pump shutoff head and shall have a free area equal to five times cross section area of pump suction opening. Straightening vanes shall extend

the full length of the orifice cylinder and shall be replaceable. Unit shall be provided with adjustable support foot to carry weight of suction piping.

B. Manufacturers: by pump manufacturer.

2.4 COMPRESSION TANKS (HORIZONTAL)

A. Compression tank shall be welded steel vessels, constructed, inspected and labeled in accordance with the ASME Code Unfired Pressure Vessels for a working pressure of 125 psig.

B. The tanks shall be provided with a water level gauge glass with brass fittings and cocks, drain outlet, connections for air control specialties, and relief valve connection.

C. All necessary gauges and relief devices as required by the ASME Code shall be provided on the tanks.

D. The capacity and physical size of the tank shall comply with scheduled data on the drawings.

E. Steel support saddles shall be provided by the tank manufacturer.

F. The tanks shall be manufactured by Amtrol, Bell and Gossett, Patterson, Stover Tanks, Taco, Wheatley, John Wood.

2.5 DIAPHRAGM-TYPE EXPANSION TANKS (VERTICAL OR HORIZONTAL)

A. Fabricate tank of continuously welded steel plate of the size shown conforming to ASME Section VIII Standards, maximum working pressure of 125 psi.

B. Provide air charging valve, drain-offs, system connection and other piping connections. Paint outside of tank with a zinc chromate primer.

C. Provide a standard cleanout hole located in the tank head.

D. Tank shall have a sealed-in heavy-duty butyl diaphragm suitable for operation from 40 to 240 degrees F.

E. Tank shall be furnished with an ASME stamp.

F. The tanks shall be manufactured by Amtrol, Bell and Gossett, Patterson, Stover Tanks, Taco, Wheatley, John Wood.

2.6 AIR SEPARATORS

A. Closed circulating water system shall have air separators provided in piping at:

1. Outlet side of heat exchangers.
2. Suction side of circulating pumps.
3. Air relief connection compression tanks.

B. Provide air separators pressure rated for 125 psi. Select capacity based on total system gpm.

C. In-Line Air Separators: Construct sizes 1-1/2" and smaller of cast iron; and sizes 2" and larger of steel.

D. Manufacturers: Provide air separators of one of the following:

Armstrong

Bell & Gossett

Patterson

Taco, Inc.

Thrush Div., Amtrol, Inc.

Wheatley

John Woods

OR

2.6 AIR SEPARATORS

A. Furnish and install, as shown on plans, a centrifugal type air separator. The unit shall have NPT or flanged inlet and outlet connections tangential to the vessel shell. Vessel shell diameter to be three times the nominal inlet/outlet pipe diameter.

B. The unit shall have an internal stainless steel air collector tube with 5/32" diameter perforations and 63% open area designed to direct accumulated air to the compression tank via an NPT connection at top of unit.

C. The unit shall have a removable galvanized steel system strainer with 3/16" diameter perforations and a free area of not less than five times the cross-sectional area of the connecting pipe. A blowdown connection shall be provided to facilitate routine cleaning of the strainer.

D. Manufacturer to furnish data sheet specifying air collection efficiency and pressure drop at rated flow.

E. A manufacturers' Data Report for Pressure Vessels, Form U-1 as required by the provisions of the ASME Boiler and Pressure Vessel Code shall be furnished for each air separator upon request.

F. Manufacturers:

Armstrong

Bell & Gossett

Patterson

Taco, Inc.

Thrush Div., Amtrol, Inc.

John Woods

Wheatley

2.7 HIGH EFFICIENCY DIRT SEPARATOR

Provide as shown on the drawings a combination full flow coalescing type high efficiency dirt and sediment separator on the condenser or other open water systems.

A. All units shall be selected at the point of peak efficiency per the manufacturer’s recommendations.

B. Dirt separators shall be fabricated steel, rated for 150 psig working pressure with entering velocities not to exceed 4 feet per second at specified GPM.

C. Vessel diameter shall be a minimum of two times pipe size. Vessel shall extend below nozzles a minimum of 4.3 times pipe size for standard units, and 5.8 times pipe size for high-velocity units.

D. Units shall include an internal bundle filling the entire vessel to suppress turbulence and provide high efficiency. The bundle shall consist of a copper core tube with continuous wound copper medium permanently affixed to the core. A separate copper medium shall be wound completely around and permanently affixed to each internal element.

E. Unit shall include a blow down valve at bottom for removal of collected dirt and sediment.

F. Dirt and sediment separator function shall be capable of removing 80% of particles 30 micron and larger within 100 passes. A properly selected strainer shall be installed upstream to collect large debris that may be left in the piping.

G. Provide removal head to facilitate internal element inspection or cleaning if required. Elements shall include tube sheets top and bottom and be manufactured as a bundle for ease or removal. Verify space required for bundle removal.

H. Manufacturer: Spirovent® model TDT for standard velocity or model THT for high velocity systems or equal in size and construction. (TDN standard velocity or THN high velocity for optional removable head.

I. Substitutions: Refer to paragraph 1.1.B and 1.6.

HIGH EFFICIENCY AIR ELIMINATOR

Provide as shown on the drawings a full flow coalescing type high efficiency air eliminator on the hot and chilled water systems.

A. All units shall be selected at the point of peak efficiency per the manufacturer's recommendations.

B. Air eliminators shall be fabricated steel, rated for 150 psig working pressure with entering velocities not to exceed 4 feet per second at specified GPM. Designated models specifically designed for high velocity systems may have an entering velocity of up to 10 feet per second.

C. Vessel diameter shall be a minimum of two times pipe size. Vessel height shall be a minimum of 4.3 times pipe size for standard units and 5.8 times pipe size for high velocity units.

D. Units shall include an internal bundle filling the entire vessel to suppress turbulence and provide high efficiency. The bundle shall consist of a copper core tube with continuous wound copper medium permanently affixed to the core. A separate copper medium shall be wound completely around and permanently affixed to each internal element.

E. Each eliminator shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.

F. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.

G. Eliminators shall include a bottom connection for use as a blow down connection for periodic cleaning.

H. Air eliminators shall be capable of removing 100% of the free air, 100% of the entrained air, and up to 99.6% of the dissolved air in the system fluid.

I. Manufacturer: Spirovent® model VSR for standard velocity or model VHR for high velocity systems or equal in size and construction.

J. Substitutions: Refer to paragraphs 1.1.B and 1.6.

HIGH EFFICIENCY AIR ELIMINATOR / DIRT SEPARATOR

Provide as shown on the drawings a combination full flow coalescing type high efficiency air eliminator / dirt and sediment separator on the hot and chilled water systems.

A. All units shall be selected at the point of peak efficiency per the manufacturer's recommendations.

B. Air eliminators / separators shall be fabricated steel, rated for 150 psig working pressure with entering velocities not to exceed 4 feet per second at specified GPM. Designated models specifically designed for high velocity systems may have an entering velocity of up to 10 feet per second.

C. Vessel diameter shall be a minimum of two times pipe size. Vessel height above the nozzle center-line shall be a minimum of 3 times pipe size for standard units and 4.5 times pipe size for high velocity units. Vessel shall extend below nozzle center-line the same distance for dirt separation.

D. Units shall include an internal bundle filling the entire vessel to suppress turbulence and provide high efficiency. The bundle shall consist of a copper core tube with continuous wound copper medium permanently affixed to the core. A separate copper medium shall be wound completely around and permanently affixed to each internal element.

E. Each eliminator shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.

F. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.

G. Unit shall include a blow down valve at bottom for removal of collected dirt and sediment.

H. Air eliminator function shall be capable of removing 100% of the free air, 100% of the entrained air, and up to 99.6% of the dissolved air in the system fluid during continuous circulation.

I. Dirt and sediment separator function shall be capable of removing 80% of particles 30 micron and larger within 100 passes. A properly selected strainer shall be installed upstream to collect large debris that may be left in the piping.

J. (Optional) Provide removal head to facilitate internal element inspection or cleaning if required. Elements shall include tube sheets top and bottom and be manufactured as a bundle for ease or removal. Verify space required for bundle removal.

K. Manufacturer: Spirovent® model VDT for standard velocity or model VHT for high velocity systems or equal in size and construction. (VDN standard velocity or VHN high velocity for optional removable head.)

L. Substitutions: Refer to paragraphs 1.1.B and 1.6.

2.8 WATER FEEDERS

A. Each water circulating system shall have make-up water introduced through a pressure regulating valve provided with a three-valve bypass and a strainer.

B. The pressure regulating valve shall be manufactured by McDonnell and Miller, A.W. Cash, Bell and Gossett.

2.9 RELIEF VALVE (WATER SYSTEMS)

A. Each water circulating system of the closed type shall be provided with a pressure relief valve selected to suit the system heat generation capacity and set at 75 psig.

B. This discharge from the relief valves shall be piped to a drain.

C. Relief valves shall be manufactured by McDonnell and Miller, Bell and Gossett, A.W. Cash Company.

2.10 BALANCING VALVES

A. Balancing valves shall be installed where indicated.

B. Provide, as shown on the plans, balancing valves with provision for connecting a portable differential (Ft. of Head) pressure meter. Each meter connection shall have pressure/temperature readout ports.

C. The balancing valves shall be either a bronze body/brass ball valve, or a Y-pattern globe valve style design and all metal parts of non-ferrous, pressure die-cast, nonporous Ametal copper alloy. Each valve can be installed in any direction without affecting flow measurement and shall provide four (4) functions:

1. Precise flow measurement
2. Precision flow balancing
3. Positive shut-off with no drop seat and teflon disc
4. Drain port suitable for hose bib fitting.

D. The valves shall have four (4) 360 deg. adjustment turns of handwheel for maximum setting with hidden memory feature to program the valve with precision tamperproof balancing setting.

E. Design Pressure/Temperature:

1/2" - 3" NPT connections 300 psig at 250 deg. F.

1/2" and 3/4" sweat connections 200 psig at 250 deg. F.

2” – 4” flanged or grooved connections 250 psig at 250 deg. F

4" flanged connections 175 psig at 250 deg. F.

F. Flow sensor: For installation in piping 5” and larger, a precision wafer type orifice insert installed between standard 125 psi at 250 deg. F ANSI flanges to monitor system flow; cast iron body with integral brass EPT check valves to accommodate a differential pressure meter; furnish with calibrated nameplate with flow range through a range of differential head pressures; provide globe valve at each sensor to adjust flow to design conditions.

G. Manufacturers: Tour & Andersson, Armstrong, Bell & Gossett, Nexus Valve, Taco, Victaulic, Wheatley.

2.11 COMBINATION VALVE PACKAGE FOR PUMPS

A. Each centrifugal pump shall be provided with the following valve assemblies:

1. Combination silent check valve, balancing valve and shut-off valve on pump discharge.

B. The combination units shall be flanged assemblies of 125 lb. ASA Class, 175 psi. W.O.G. @ 300 degrees F. The combination units shall be suitable for vertical or horizontal installation with the stem pointing up.

C. The body and bonnet shall be cast semi-steel; and the stem, seat and disc shall be bronze. The valve shall be designed for repacking under pressure.

D. The unit shall be provided with a calibrated stem indicator, and the check valve shall have a stainless steel spring and be provided with disc designed for quiet operation at low flow rates.

E. Manufacturers: by Pump Manufacturer.

PART 3 – EXECUTION

3.1 CIRCULATING PUMPS

A. Pump shall be installed in accordance with recommendations of the Hydraulic Institute.

B. Suction reducers shall be eccentric and located at the pump suction. Discharge increasers shall be

concentric and located at the pump discharge.

C. Suction and discharge piping shall be adequately supported without imposing any load on the pump casing.

D. Pressure gauges shall be installed at the suction and discharge of each pump.

E. Vibration isolation equipment shall be provided where noted.

F. Impeller diameter used shall be approximately 85% of the maximum impeller diameter capable of being supplied for each pump.

G. Where pumps with packed stuffing boxes are used, piping shall be provided to carry gland leakage to the nearest drain.

H. The motor nameplate horsepower shall not be exceeded under any conditions of pump operation.

I. Prior to shipment, each pump shall be tested to insure its capability to produce the required capacity at the design head, and when requested written verification of this test shall be supplied.

J. Before grouting and piping the pump, the Contractor shall check to insure pump alignment is satisfactory, and where required, realign the pump. Fill baseplate with non-shrink grout to the top of the base rail.

K. Start-up service shall be provided by the pump manufacturer or his representative. This service shall include the following:

1. Check alignment
2. Check absence of pipe strain
3. Check lubrication
4. Check rotation
5. Take suction and discharge pressure gauge readings and compare with pump nameplate for operating head.
6. Take voltage and current readings and compare with motor nameplate.
7. Insure proper maintenance manuals are available if required.

3.2 BYPASSES

A. Three-valve bypasses shall be provided in piping at main system control valves, at control valves for heat exchangers, domestic hot water generators, central station air handling units, and where indicated on drawings.

B. The bypasses shall consist of two gate valves and one globe or angle valve. The bypass pipe size shall be at least equal to the control valve size.

3.3 PIPING SYSTEM DRAINS

A. All piping shall be graded or pitched toward drain locations which shall be provided with gate valve unless otherwise indicated on drawings or specified. Individual risers may be drained through removable plugs or caps.

B. Drain valves shall be provided at all major components in systems including boilers, pumps, heat exchangers, cooling towers, and similar equipment.

3.4 ECCENTRIC PIPE FITTINGS

A. Eccentric pipe fittings shall be furnished and installed in all piping and circulated water piping where a change in pipe size occurs in a horizontal run. In water systems the top of the adjacent pipe sections shall be maintained level.

3.5 CHEMICAL CLEANING

A. New boilers shall be boiled out with an alkaline type boiling out compound to remove grease, oil, mil scale and other foreign matter. The compound should be used at the rate of 1-1/2 pounds per 20 boiler horsepower. After the boiling out period, the boiler shall be completely drained, flushed and refilled with fresh water.

B. Closed re-circulating systems shall be filled and sufficient detergent and dispersant added to remove all dirt, oil and grease. System shall be circulated for at least 48 hours after which a drain valve at the lowest point shall be opened and allowed to bleed while the system continues to circulate. The automatic make-up valve shall be checked to be sure it is operating. Bleeding shall continue until water runs clear and all detergent is removed. A sample of water shall be tested and if pH exceeds 8.0, draining should be resumed.

C. Drain all detergent solution from system piping and equipment to nearest floor drain or indirect waste point connected to the building's sanitary system.

END OF SECTION 23 0500

SECTION 23 0510

WATER TREATMENT (HVAC)

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provision of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 23 0200 for HVAC General Provisions.

C. Refer to Section 23 0210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes labor, material, equipment and supervision to provide a complete water treatment system for the following:

1. Cleaning and treatment of circulating HVAC chilled water system, hot water and steam system.

a. Cleaning Compounds.

b. Chemical Treatment for Closed Loop Systems.

1.3 REFERENCE STANDARDS

A. Refer to Section 23 0200 for a general description of requirements applying to this section.

B. Requirements established within the portions of the Project Manual titled Division 1, General Requirements, are collectively applicable to the work of this section.

C. Technical Services: Provide the services of an experienced water treatment chemical engineer or technical representative to direct flushing, cleaning, pre-treatment, training, debugging, and acceptance testing operations; direct and perform chemical limit control during construction period and monitor systems for a period of 12 months after acceptance, including not less than four service calls and written status reports. Minimum service during construction/start-up shall be 8 hours.

D. Field Quality Control and Certified Laboratory Reports: During the one year guarantee period, the water treatment laboratory shall provide not less than 12 reports based on on-site periodic visits, sample taking and testing, and review with Owner, of water treatment control for the previous period. In addition to field tests, the water treatment laboratory shall provide certified laboratory test reports. These monitoring reports shall assess chemical treatment accuracy, scale formation, fouling and corrosion control, and shall contain instructions for the correction of any out-of-control condition.

E. Log Forms: Provide one year supply of preprinted water treatment test log forms.

1.4 SUBMITTALS

In accordance with Section 23 0200 provide the following:

A. Manufacturer's Literature and Data:

1. Cleaning compounds and procedures.

2. Chemical treatment for closed systems.

3. Chemical treatment for steam systems, including installation and operating instructions.

4. Chemical treatment for open loop systems.

5. Glycol water heat transfer systems.

B. Water analysis verification.

C. Materials Safety Data Sheet for all proposed chemical compounds.

D. Maintenance and operating instructions.

PART 2 – PRODUCTS

2.1 CLEANING COMPOUNDS:

A. Alkaline phosphate or non-phosphate detergent/surfactant/specifically to remove organic soil, hydrocarbons, flux, pipe mill varnish, pipe compounds, iron oxide, and like deleterious substances, with or without inhibitor, suitable for system wetted metals without deleterious effects.

NOTE: Provide aluminum safe cleaning compounds in heating hot water systems which use an aluminum block boilers; coordinate treatment materials with the boiler manufacturer or their representative based on written recommendations.

B. Refer to Section, PIPING SYSTEMS & ACCESSORIES - HVAC, PART 3, for flushing and cleaning procedures.

2.2 CHEMICAL TREATMENT FOR CLOSED LOOP SYSTEMS:

A. Inhibitor: Provide sodium silicate, sodium nitrite/borate, or other approved proprietary compound suitable for make-up quality and make-up rate and which will cause or enhance bacteria/corrosion problems or mechanical seal failure due to excessive total dissolved solids. Shot feed manually. Maintain inhibitor residual as determined by water treatment laboratory, taking into consideration residual and temperature effect on pump mechanical seals.

NOTE: Provide aluminum safe inhibitors in heating hot water systems which use an aluminum block boiler; Coordinate treatment materials with the boiler manufacturer or their representative based on written recommendations.

B. pH Control: Inhibitor formulation shall include adequate buffer to maintain pH range of 8.0 to 10.0.

C. Performance: Protect various wetted, coupled, materials of construction including ferrous, and red and yellow metals. Maintain system essentially free of scale, corrosion, and fouling. Corrosion rate of following metals shall not exceed specified mills per year penetration; ferrous, 0.5; brass, 0.2; copper, 0.15. Inhibitor shall be stable at equipment skin surface temperatures and bulk water temperatures of, respectively, not less than 250 and 125 degrees Fahrenheit. Heat exchanger fouling and capacity reduction shall not exceed that allowed by fouling factor 0.0005.

D. Pot Feeder: By-pass type for chemical treatment schedule 10 gauge heads, 3/4-inch system connections and large neck opening for chemical addition. Feeder shall be bypass filter feeder, minimum five gallon, installed per detail on the drawings, for chilled water system, and for hot water system.

E. Water Analysis: Confirm raw water analysis or provide analysis if none is furnished.

Description	Year (Avg.)
Silica ($Si0_2$)	_____
Insoluble	_____
Iron & Aluminum	_____
Calcium (Ca)	_____
Magnesium (Mg)	_____
Sodium & Potassium (Na & K)	_____

Carbonate (CO_3) _____

Bicarbonate (HCO_3) _____

Sulfate (SO_4) _____

Chloride (Cl) _____

Nitrate (NO_3) _____

Turbidity _____

pH _____

Residual Chlorine _____

Total Alkalinity _____

Non Carbonate Hardness _____

Total Hardness _____

Dissolved Solids _____

Fluorine _____

F. Conduct performance test to prove capacity and performance of treatment system.

Raw water total hardness, ppm.

Concentration cycles.

Raw water, pH.

System water, pH.

Chemical solution used.

Acid solution used, obe.

Quantity or chemical solution injected into system per cycle.

Quantity of acid injected into system per cycle.

Make up water required.

Waste to drain requirement.

G. Recommended Conditions

1. Buffered Nitrite:
   a. For temperatures 140ºF to 180ºF - 1000 ppm as sodium nitrite.
2. Molybdate:
   a. 50 - 100 ppm as molybdate (chilled water).
3. pH - 7.0 to 10.0

NOTE: Provide pH in the range of 7.0 to 8.25 for heating hot water systems which use an aluminum block boiler; Coordinate with the boiler manufacturer or their representative based on written recommendations.

PART 3 – EXECUTION

3.1 INSTALLATION:

A. Delivery and Storage: Deliver all chemicals in manufacturer's sealed shipping containers. Store in designated space and protect from deleterious exposure and hazardous spills.

B. Install equipment furnished by the chemical treatment supplier and charge systems according to the manufacturer's instructions and as directed by the Technical Representative.

C. Perform tests and report results.

D. Instruct owner personnel in system maintenance and operation.

3.2 INSPECTIONS AND MAINTENANCE:

A. Furnish complete inspection and maintenance service on water treatment equipment for a period of one year after completion and acceptance of the water treatment equipment installation. This maintenance service shall begin concurrently with the guarantee. Maintenance work shall be performed by skilled personnel directly employed and supervised by the same company that provided the water treatment equipment specified herein.

B. The maintenance service shall include the following:

1. Monthly systematic examination of equipment.
2. Cleaning, lubricating, adjusting, repairing and replacing of all parts as necessary to keep the equipment in first-class condition and proper working order.
3. Furnishing all lubricant, cleaning materials and parts required.
4. The operational system shall be maintained to the manufacturer's standards specified including any changes and/or adjustments required to meet varying conditions.
5. Provide 24 hour emergency call-back service which shall consist of promptly responding to calls within two hours for emergency service should a shutdown or emergency trouble develop between regular examinations. Overtime emergency call-back shall be limited to minor adjustments and repairs required to protect the immediate safety of the equipment.
6. Service personnel shall report to the owner or his authorized representative upon arrival and again upon completion of the required work. A copy of the work ticket containing a complete description of the work performed shall be given to the owner.
7. The Contractor shall maintain a log in the boiler room and chiller room. The log shall list the date and time of all monthly examinations and all trouble calls. Each trouble call shall be fully described including the nature of the call, necessary correction performed and/or parts replaced.

3.3 PACKAGED REVERSE OSMOSIS SYSTEM

A. Install where indicated on drawings.

B. Follow manufacturer’s recommendations for installation procedures.

C. Provide each unit with water supply and drain connection.

END OF SECTION 23 0510

SECTION 23 0600

AIR DISTRIBUTION & ACCESSORIES - HVAC

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 23 0200 for HVAC General Provisions

C. Refer to Section 23 0210 for HVAC Basic Materials & Methods.

D. This Contractor shall coordinate with the work of Division 26 and the Fire Alarm System vendor for locations and mounting of all duct smoke detectors. These devices are shown on the Mechanical Drawings for reference only to show the intent of the work. All locations shall be determined based on approved shop drawings from the Fire Alarm System vendor and the Contractor for the work of Division 26, Electrical. Mount smoke detectors in the supply and return air stream at each unit in accordance with NFPA 72.

1.2 DESCRIPTION OF WORK

A. This Section includes labor, material, equipment and supervision to provide a complete air distribution system as specified herein and as shown on drawings.

1. Ductwork – Single Wall, Square and Rectangular
2. Ductwork – Single Wall, Spiral Round
3. Flexible Air Duct
4. Flexible Connections
5. Dampers
6. Air Diffusers, Registers, and Grilles
7. Louvers

1.3 REFERENCE STANDARDS

A. Refer to Section 23 0200 for a general description of requirements applying to this section.

B. Requirements established within the portions of the Project Manual titled Division 1, General Requirements, are collectively applicable to the work of this section.

C. IMC (International Mechanical Code).

D. SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.)

E. American Society of Heating, Refrigerating and Air Conditioning Engineers' recommendations in ASHRAE Guide shall apply to this work.

F. ARI Standard 885 - Standard for Estimating Occupied Sound Levels in the Applications of Air Terminals and Air Outlets.

G. UL (Underwriter's Laboratories, Inc.)

H. NFPA 90A shall apply to this work.

I. State Fire Prevention Regulations.

1.4 QUALITY ASSURANCE

A. Refer to Section 23 0210 for a general description of requirements applying to this Section.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 23 0200.

B. Submit the following:

1. Shop drawings of all sheet metal. Indicate all steel, piping, conduit, and Architectural/Structural features to demonstrate complete coordination. Scale shall not be less than ¼".

   a. Shop drawings shall indicate the sizes and lengths of each section of ductwork as well as all system components such as coils, VAV boxes, access doors, dampers, diffusers and register locations. Also indicate the type of joints used and where internal acoustic lining or insulation, if required, will be utilized.

   b. The location of the duct runs and the air outlets shall be closely coordinated with all other trades by the sheet metal contractor to avoid interference. The shop drawings shall show the contact surfaces adjacent to the ducts or air outlets and the space assigned for concealment. The drawings shall indicate principal items of equipment, adjacent piping and conduit, etc., the location of which shall be secured from the contractors of other trades.

   c. Sheet Metal Contractor to include resubmissions of the shop drawings to the Engineer. The resubmissions are to include all corrections to previous submissions.

2. Manufacturer's literature and performance data of all equipment and devices.

3. Samples: Furnish color samples, etc., at request of the Architect.

1.6 SUBSTITUTIONS

A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but shall not be limited to space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, they shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 – PRODUCTS

2.1 DUCTWORK (SINGLE WALL, SQUARE AND RECTANGULAR)

A. All ductwork shall be fabricated in accordance with SMACNA "HVAC Duct Construction Standards - Metal and Flexible" latest Edition except as described below. The minimum thickness of metal ductwork is 26 gauge. Fabrication requirements shall be based on ductwork subjected to positive or negative pressures of **2"** W.G. Ductwork systems shall be sealed to SMACNA "Seal Class **"A"** Standards. Alternatively, "Ductmate" System 45 can be used in accordance with manufacturer's specifications. Drive slip joints are not permitted.

Exception: For ductwork <u>smaller</u> than 12" x 8", Contractor may provide slip and drive joints with all joints sealed with Hardcast tape and mastic system.

B. Rectangular ducts for **2”** W.G. or less, positive or negative pressure shall be per SMACNA Table **1-7.** Longitudinal seams shall be Pittsburgh Lock Type L-l per SMACNA Figure 1-5. Transverse joints shall be standing seam type T -15 per Figure 1-4.

1. In the event that material size is not compatible with duct size and segmenting must be utilized to fabricate duct, use SMACNA Figure 1-5, seam L-4 (Standing Seam).

C. Joints:

1. Per SMACNA Transverse Joint Reinforcement Table 1-12, only joints T -22, T -25a, T -25b and Proprietary slip on flanges will be acceptable.
2. Joints T -25a and T -25b that have stress fractures from bending will not be accepted.
3. All joints will have butyl gasket 3/16" thick by 5/8" wide installed per manufacturers installation instructions.

D. Ductwork systems for this standard shall be galvanized sheet steel, commercial quality of lock - forming grade, conforming to ASTM coating standards A-525 or A-527 with coating of designation G-60. For corrosive or moist conditions, use coating designation G-90.

E. The size and configuration of each duct shall be indicated on design drawings. Where thicker sheets or different types of materials are required, they shall be specified on the design drawings or in the project specifications.

2.2 DUCTWORK (SINGLE WALL, SPIRAL ROUND)

A. Design Pressure: **2”**

B. Leakage: All ductwork shall meet SMACNA Class "A" leak standards.

C. Fabrication:

1. Gauges, reinforcing angles, seams, joints, fabrication methods, installation methods and practices, duct reinforcement, fabricated dampers and devices installed in duct system, fittings, etc., shall conform to the latest editions of SMACNA standards for construction in accordance with requirements indicated in these specifications.
2. Minimum metal gauges shall be 26 gauge (.019). Follow SMACNA Table 3-2A for Positive pressure and Table 3-2B for Negative pressure.

D. Joints:

1. Duct up to 36" diameter - Male/Female beaded slip joint similar to SMACNA Figure 3-2, joint RT-1 or RT-5, as long as it meets the criteria for the system design pressure. Fittings shall be undersized to fit into spiral duct. All joints shall be secured with a minimum of 4 screws on each duct section (equally spaced). Seal joint with an approved sealant compound, continuously applied prior to assembly of joint and after fastening, making certain that the majority of the sealant resides on the interior of the joint.
2. Duct 37" - 60" diameter: Companion angle Vanstone with full face gaskets having bolt holes punched through prior to insertion of bolts. Gasketing shall be 1/8" thick. Joint is per SMACNA Figure 3-2, joint RT -2 and RT -2A.
3. For all dust collection and particulate carrying duct, SMACNA Figure 3-2, joint RT -3 up to 16" diameter and RT -2 or RT -2A are the only acceptable joints. RT -3 joints do not require any additional sealant as long as the band has gasketing installed by manufacturer. Joints RT -2 and RT -2A require full face gaskets having bolt holes punched through prior to insertion of bolts. Gasketing shall be 1/8" thick. There shall be no fasteners penetrating the duct for collection systems.

4. In lieu of beaded slip connections or Vanstone angle ring connections (the above-mentioned joints), there are proprietary connections that may be used, as long as they meet the pressure criteria set forth in this specification.

2.5 FLEXIBLE AIR DUCT

A. Insulated flexible air duct shall be non-metallic. Air duct shall comply with the latest NFPA Bulletin No. 90A and be labeled as Class 1 Air Duct, U.L. Standard No. 181.

B. Air ducts shall be suitable for working pressure of not less than plus 10.0 and minus 0.5 inches of W.G.

C. Non-metallic air duct shall be two element spiral construction composed of a corrosion resisting metal supporting spiral and a vinyl coated fiberglass base fabric and shall be mechanically interlocked together.

D. Insulation shall be fiberglass flexible blanket with vapor barrier outer jacket of polyethylene or reinforced mylar. Maximum thermal conductance of 0.23 Btu/Hr./SF/Inch at 75 deg. F temperature.

E. Approved manufacturers shall include the Wiremold Company, Flexmaster USA, Owens-Corning, Thermaflex Flex Vent.

OR

A. Core material shall be an acoustical spun bond nylon fabric supported by helically wound galvanized steel. The fabric shall be mechanically fastened to the steel helix without the use of adhesive. The core shall maintain its free area and a center line radius of 1.0 or better.

B. The internal working pressure rating shall be at least as follows with a bursting pressure of at least 2½ times the working pressure.

1. Positive: 6 inches W. G.
2. Negative: 5 inches W. G.

C. The duct shall be rated for a velocity of at least 5,500 feet per minute.

D. Suitable for operating temperatures of at least 250°F.

E. Minimum Acoustic Performance:

1. The insertion loss (dB) of a 9 foot length of duct when tested in accordance with ASTM E 477 at a velocity of 2,500 feet per minute shall be at least:

	125 Hz	250 Hz	500 Hz	1,000 Hz	2,000 Hz	4,000 Hz
1) 8 inch dia.	27	27	32	33	37	33
2) 12 inch dia.	24	23	30	31	37	25

F. Insulation shall be fiberglass flexible blanket with metalized vapor barrier, rated for R6.

G. Manufacturer: Flexmaster USA

2.6 FLEXIBLE CONNECTIONS

A. Required between ductwork and suction and discharge connection of all fans and air handlers.

B. Material: Woven fiberglass with mounting hardware tested in accordance with UL Standard 181, listed and labeled as Class 0 or 1.

C. Manufacturer: Ventfabrics, Inc., Durodyne, Dynair, Ductmate Pro Flex.

2.7 DAMPERS

A. Provide where indicated and required to control flow of air and balance system.

B. Round dampers shall be single blade, molded synthetic bearings at each end, 20 gauge galvanized steel, adjusting quadrant and locking device. Round dampers shall be Ruskin Model MDRS25.

C. Rectangular and square dampers shall be opposed blade within 16 gauge galvanized steel channel frame with corner brace, 16 gauge galvanized steel blades; molded synthetic bearings and hex steel shafts, exposed or concealed linkage, adjustable quadrant and locking device. Dampers shall be Ruskin Model MD35.

D. Approved Manufacturers: Ruskin, Arrow, Nailor-Hart, Pottorff, Lloyd Industries, Inc., Cesco Products, Louvers & Dampers, United Enertech.

2.8 AIR DIFFUSERS, REGISTERS, AND GRILLES

A. Registers & Grilles:

1. Registers and grilles shall be steel construction, fixed single deflection type, with clips and/or flange holes and screws (as required by Architectural finishes) to secure registers to ceiling construction. Face bars shall be inclined 30 degrees. Registers and grilles shall be factory primed and painted with a baked-on white enamel finish.

2. Wall Supply Registers:

a. Provide manufacturer's standard wall registers where shown; of size, shape, capacity, type of materials and components indicated.

b. Register Materials: Steel construction: Manufacturer's standard stamped sheet steel frame and adjustable blades.

c. Register Faces: **Vertical/Horizontal** Straight Blades: **Vertical/Horizontal** blades, individually adjustable, at manufacturer’s standard spacing.

d. Register Patterns: Double Deflection: 2 sets of blades in face, rear set at 90 degrees to face set.

e. Register Finishes: Aluminum Enamel: Air-dried aluminum enamel prime finish.

3. Ceiling Return Register (CR):

a. Ceiling registers shall have a perforated face with 3/16-inch diameter holes on 1/4-inch staggered centers and no less than 51 percent free area. Perforated face shall be aluminum according to the model selected. The back pan shall be one piece stamped heavy gauge steel of the sizes and mounting types shown on the plans and outlet schedule.

b. The finish shall be #26 white. The finish shall be a baked on anodic acrylic paint, with a pencil hardness of HB to H. Inside of back pan shall be painted flat black.

c. Titus Model: PAR Price Model PDDR

PART 3 – EXECUTION

3.1 DUCTWORK

A. Dimensions on drawings are inside dimensions. Sheet metal dimensions shall be increased to suit thickness of acoustic duct lining, if applicable.

B. Ducts shall be concealed unless otherwise indicated.

C. Changes in direction shall be made with radius bends or turning vanes.

D. Supports shall be galvanized steel for steel ductwork and aluminum for aluminum ductwork.

E. Locate ceiling air diffusers, registers, and grilles on "Reflected Ceiling Plans". Unless otherwise indicated, locate units in center of acoustical ceiling modules.

F. Do not install ductwork directly above any electrical equipment.

G. Ductwork shall be supported per SMACNA Standards except as follows:

1. Rivet or screw to side of duct when using flat strap hangers. Rivet or screw to bottom of duct when using trapeze hangers.
2. Extend hangers down the side of the duct at least 9"; pass hangers under ducts less than 9" deep.
3. Space hangers not more than 8' on centers for ducts up to 18" wide and 4' on centers for ducts over 18" wide.
4. Wire hangers are not acceptable.
5. Support ductwork from building structure with expansion bolts, rods, steel angles or channels installed to meet existing or new building conditions.
6. Drilling into the roof deck is not permitted.
7. Driving nails into anchors is not permitted.

H. Air Flow Control:

1. Major take-offs: Install volume control dampers.
2. Branches: Install volume control dampers in all branches and at tap in branch take-off connections.
3. Elbows: Use unvaned elbows with throat radius equal to width of duct and full heel radius; provide turning vanes where full throat and heel radius are not possible.
4. Transitions: Make transitions in ducts as required by structural or architectural interferences.
   a. Proportion airways to compensate for any obstructions within duct.
   b. Avoid dead ends and abrupt angles.
   c. Do not exceed 15 degrees slope on sides of transitions.

I. For all exterior single wall, square or rectangular ductwork, ensure that the top of all horizontal ductwork is crowned to minimize accumulation of weather on top of the finished insulation system jacket specified in Section 23 0230.

3.2 LOUVERS

A. When open louvers are provided on a job, and the louver is open on the back, the contractor shall provide a 2" deep drip pan. Pan shall extend the full length of the louver. Drip pan shall be fabricated from a minimum of 24 gauge galvanized sheet steel. Cross break pan for rigidity. All seams to be welded.

B. Drip pans shall be securely fastened to building structure. Do not hang pans from ductwork, piping systems or equipment. Contractor shall submit shop drawings, showing pan detail and methods of support.

OR

3.2 LOUVERS

A. Locate and place louver units level, plumb and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible.

C. Provide perimeter reveals and openings of uniform width for sealants and joint fillers.

D. Repair damaged finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alternations and refinish entire unit or provide new units.

E. Protect galvanized and non-ferrous metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry or dissimilar metals.

3.3 FLEXIBLE AIR DUCT

A. When flexible duct is used for final connection between duct mains on branches and diffusers on registers. The maximum length of flexible ductwork shall be 5'-0" in length.

B. Flexible ductwork shall be properly hung at the tap collar in order to prevent eventual wear and damage to the flexible duct.

C. The ceiling tile system should not be considered a support on which to lay flexible duct. Refer to SMACNA Standards for proper installation.

3.4 DUCT SYSTEM LEAK SEALING

A. Joints in duct systems at duct heaters, air monitors, fire dampers, sound traps, supply air terminals including air handling light fixtures, shall be sealed to prevent air leakage.

B. All duct joints and seams in medium pressure and high pressure duct systems shall be sealed to SMACNA Seal Class" A" Standards to prevent air leakage.

C. In the event there is in excess of 5% air leakage indicated in low pressure duct systems, it shall be the Contractors responsibility to seal the duct system. The amount of sealing necessary shall be that required to obtain the design air quantity at each terminal.

D. Duct sealing shall be by means of high velocity duct sealants such as Hardcast and/or Neoprene gaskets. Type of sealant and method of application shall conform to recommendations in SMACNA high velocity duct construction standards.

3.5 DUCTWORK TESTING

A. The following ductwork shall be pressure leak tested:

1. Supply ductwork
2. Return ductwork
3. Exhaust ductwork
4. Outside air intake ductwork

B. All tests shall be conducted in accordance with AABC National Standards.

C. Ducts to be tested at 100% maximum of static pressure before any duct is insulated externally and concealed in accordance with SMACNA Standards.

D. Calculate the allowable leakage using leakage factor of 5% of Design Air Flow.

E. Select a limited section of duct for which the estimated leakage will not exceed capacity of the test apparatus.

F. Connect the blower and flow meter to the duct section and provide temporary seals at all openings of the ductwork.

G. Start the blower motor with the inlet damper closed. Increase pressure until the required level is reached.

H. Read the flow meter and compare the leakage in cfm. Reading should be 5% or less of design flow for the duct segment being tested.

I. If reading is more than 5% of design flow, depressurize duct, repair all leaks and retest until 5% or less of design flow is obtained.

J. Complete test reports and obtain Owner's witness signature.

K. Remove all temporary blanks and seals.

L. Warning: Do not overpressure duct.

3.6 EQUIPMENT

A. Test apparatus shall consist of an airflow measuring device, flow producing unit, pressure indicating devices and accessories necessary to connect the metering system to the test specimen.

B. The Contractor conducting tests shall arrange for or provide all temporary services, all test apparatus, all temporary seals and all qualified personnel necessary to conduct the specified testing.

C. Test apparatus shall be accurate within plus or minus 7.5% at the indicated flow rate and test pressure and shall have calibration data or a certificate signifying manufacture of the meter in conformance with the ASME Requirements for Fluid Meters. Verification of above, to be supplied to Owner upon request.

D. Pressure differential sensing instruments shall be readable to 0.05" scale division for flow rates below 10 cfm or below 0.5" w.g. differential. For flows greater than 10 cfm scale divisions of 0.1" are appropriate. U-tube manometers should not be used for reading less than 1" of water.

E. Liquid for manometers shall have a specific gravity of 1 (as water) unless the scale is calibrated to read in inches of water contingent on use of a liquid of another specific gravity, in which case the associated gauge fluid must be used.

F. Instruments must be adjusted to zero reading before pressure is applied.

END OF SECTION 23 0600

SECTION 23 0605

FANS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 23 0200 for HVAC General Provisions

C. Refer to Section 23 0210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes labor, material, equipment and supervision to provide a complete air distribution system as specified herein and as shown on drawings.

1. Centrifugal Direct Drive Cabinet Fan

B. Refer to Section 23 0200 for a general description of requirements applying to this section.

C. Requirements established within the portions of the Project Manual titled Division 1, General Requirements, are collectively applicable to the work of this section.

D. IMC (International Mechanical Code)

E. SMACNA (Sheet Metal and Air Conditioning Contractors National Association, Inc.)

F. American Society of Heating, Refrigerating and Air Conditioning Engineers' recommendations in ASHRAE Guide shall apply to this work.

G. UL (Underwriter's Laboratories, Inc.)

H. NFPA 90A shall apply to this work.

I. State Fire Prevention Regulations.

1.4 QUALITY ASSURANCE

A. Refer to Section 23 0210 for a general description of requirements applying to this Section.

B. Whenever a variable frequency PWM drive is installed to control an AC motor, a maintenance-free, circumferential, conductive micro fiber shaft grounding ring shall be installed on the AC motor drive end to discharge shaft currents to ground. Recommended part: AEGIS SGR™ Bearing Protection Ring, as made by Electro Static Technology. Install in accordance with the manufacturer’s written instructions.

1.5 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 23 0200.

B. Submit the following:

1. Shop drawings of all sheet metal. Indicate all steel, piping, conduit, and Architectural/Structural features to demonstrate complete coordination. Scale shall not be less than 1/4" = 1'-0".

2. Manufacturer's literature and performance data of all equipment and devices.

1.6 SUBSTITUTIONS

A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents and as described within the specifications. This shall include, but shall not be limited to space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, they shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 – PRODUCTS

2.1 CENTRIFUGAL DIRECT DRIVE CABINET FAN

A. Fan shall be centrifugal, direct driven in-line type. The fan housing shall be of the square design, constructed of heavy gauge galvanized steel and shall include square duct mounting collars. One side of the housing shall be equipped with a hingeable service door assembly supporting the motor, wheel and inlet cone. The door assembly must swing out for cleaning, inspection, or service without dismantling the fan in any way.

B. Fan wheel shall be of the aluminum backward inclined centrifugal type. Wheels shall be dynamically and statically balanced. Fan motors shall be permanently lubricated, heavy duty type carefully matched to the fan loads.

C. Flexible wiring leads shall be provided from the fan motor to an external mounted junction box and disconnect switch permitting the service door to be hinged without disconnecting the field wiring.

D. All fans shall bear the AMCA Certified Rating Performance Seal for both air and sound performance.

E. Manufacturer: Penn Ventilator, Greenheck, Carnes, Loren-Cook, American Coolair/ILG, Breidert, Hartzell.

PART 3 – EXECUTION

3.1 FANS, EQUIPMENT AND ACCESSORIES

A. Install in accordance with manufacturer's details and instructions.

B. Mount fan speed control at the fan to facilitate mechanical balancing. Power wiring shall be part of the work of Division 26.

C. Perform field mechanical balancing in accordance with Section 23 0950: TESTING AND BALANCING OF MECHANICAL SYSTEMS.

D. Install units in accordance with manufacturer’s installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer’s recommended clearances.

E. Support: Install and secure roof curb structure, in accordance with National Roofing Contractor’s Association (NRCA) installation recommendations and shop drawings. Install and secure units on curbs and coordinate roof penetrations and flashing.

F. The Mechanical Contractor shall own as a part of his work, the following:

Provide one (1) additional drive set, if necessary, to obtain final design balancing requirements. The Mechanical Contractor shall coordinate with Balancing Firm and equipment manufacturer for drive selection, including belts and pulleys.

END OF SECTION 23 0605

SECTION 23 0725

TERMINAL HEATING UNITS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 23 0200 for HVAC General Provisions

C. Refer to Section 23 0210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes work necessary and/or required and materials and equipment for construction of a complete system. Such work includes, but is not limited to the following:

1. Cabinet Heaters
2. Convectors (Fin-Tube Type)
3. Hot Water Coils
4. Fin-Tube Radiation
5. Electric Unit Heaters

1.3 REFERENCE STANDARDS

A. Refer to Section 230200 for a general description of requirements applying to this section.

1.4 QUALITY ASSURANCE

A. Refer to Section 230210 for a general description of requirements applying to this Section.

1.5 SUBMITTALS

A. Submit shop drawings in accordance with Section 230200.

B. Submit shop drawings and descriptive date for all equipment specified in this section.

1.6 SUBSTITUTIONS

A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items furnished and installed by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements.

PART 2 – PRODUCTS

2.1 CABINET HEATERS

A. Provide cabinet heaters including chassis, heating elements, fans, motor and insulation.

B. Chassis: Galvanized steel wraparound structural frame with edges flanged.

C. Insulation: Faced, heavy density glass fiber.

D. Cabinet: Vertical semi-recessed/recessed/surface-mounted model as scheduled on the drawings, 16 gauge four sided overlap front panel with stiffeners. Clean cabinet parts, bonderize, phosphatize, and flow-coat with baked-on primer.

E. Coils: Aluminum fins, copper tubes, mechanically expanded for a permanent bond. Provide manual air vent.

F. Grilles: Intake and outlet grilles shall be integral, stamped 15 degrees deflection.

G. Fans: Provide direct drive centrifugal, forward curved double width fan.

H. Motors: Provide two-speed permanent split capacitor type motors (or variable speed) with integral overload protection and motor cords for plug-in to junction box in unit.

I. Provide HI/LO/OFF fan control (concealed).

J. Manufacturers: Airtherm Manufacturing Co., American Air Filter, Embassy Industries, Daikin McQuay, Modine, Rittling, Sterling, Trane, Vulcan.

2.2 CONVECTORS (FIN-TUBE TYPE)

A. Fin-tube heating element shall consist of a single seamless copper tube as the primary heating surface, and rectangular plate type aluminum fins as the secondary heat transfer surface. The fins shall be mechanically fastened and equally spaced along the tubes to form a permanently tight bond between tube and fins. Heating element capacities shall be I-B-R approved.

B. The enclosure shall be not less than 16-gauge steel which shall be supported from a 20 gauge steel continuous backplate fastened to wall. A die-formed outlet grille in the enclosure shall extend from top to partly around front.

C. Accessories according to installation requirements shall include end caps, corner pieces, wall sleeves, wall strip, column enclosures and support hangers.

Factory Applied - Prime coat for field paint

- Baked enamel (Color selected by Architect)

D. Manufacturers: Airtherm Manufacturing Co., American Air Filter, Embassy Industries, Daikin McQuay, Modine, Rittling, Sterling, Trane, Vulcan.

2.3 HOT WATER COILS

A. Provide coils of size and in location indicated, and of capacities and having performance data as scheduled. Certify coil capacities, pressure drops and selection procedures in accordance with AHRI 410.

B. Construct fins of continuous aluminum configurated plate-fin type with full fin collars for accurate spacing and maximum fin-tube contact.

C. Construct tubes of 5/8" or 1/2" seamless copper tubing, .025" nominal wall thickness, arranged in parallel pattern with respect to airflow.

D. Construct headers of gray cast iron. Hydrostatically test to 400 psi before assembly.

E. Construct casings of 14 gauge continuous coated galvanized steel with formed end supports and top and bottom channels.

F. Proof test coils at 300 psi, leak test at 200 psi under water.

G. Manufacturers: Carrier, York/Johnson Controls, The Coil Co., Trane, USA Coil.

2.4 FIN-TUBE RADIATION

A. Provide fin-tube heating elements and enclosures, together with required mounting components and accessories.

B. Heating Elements shall consist of full-hard aluminum plate fins not less than .016" thick and actually embedded in copper seamless-drawn tube guaranteed for working pressure of at least 150 psi at 300 deg. F temperature.

C. Enclosures and accessories:

1. Shall be of style and dimensions indicated on plans and shall be fabricated from 16-gauge zinc-coated steel. Top of enclosures and 90 deg. corners shall consist of a heavy continuous enclosure aluminum extrusion deep-etched and hard anodized 204 R-1, with vanes sloped toward room, factory assembled to steel front skirts. Aluminum extrusion on enclosure top shall have pencil-proof air discharge slots.

2. Bottom of enclosure skirt shall have a double break for lateral stiffness, top shall be provided with deep-web gussets, and vertical stiffeners with 1/2" deep flanges shall be provided at enclosure joints.

3. Enclosures and 90 deg. corners shall have flush joints with no exposed fasteners. End enclosures and end trims shall have roll- flanged edges, allowing enclosures to telescope within, and shall have no visible fasteners.

D. Support components:

1. Shall consist of continuous mounting channel and bracket and element hangers installed every 3 to 4 feet.

2. Continuous 20-gauge roll-formed mounting channel, fabricated from zinc-coated steel, shall position extruded aluminum top 7/8" from wall.

3. The mounting channel shall be provided with a 16-gauge back plate, covering all holes and slot in channel, and flanged at bottom.

4. Support brackets shall be die-formed from 3/16" thick steel, 1-1/2" wide and shall be lanced to receive bottom flange of enclosure, which shall be held securely with set screw.

5. 16-gauge die-formed saddle shall positively position heating element away from brackets and enclosure joints and allow 1-5/8" lateral movement for expansion and 1-1/2" height adjustment for pitch. Nylon-coated support arm shall allow free-sliding of saddle.

E. Access doors shall be provided where indicated. Doors shall be at least 8" x 8" size, hinged, located in (enclosure front skirt) (12" long access panel) and provided with tamperproof operator.

F. Dampers shall be provided where indicated. Blades shall be fabricated from 18-gauge zinc-coated steel, flanged for rigidity and permanently attached to enclosures. Threaded damper screw and trunnion shall provide positive operation in any position between open and closed. Operator shall be tamperproof.

G. Finish: All parts of the enclosure shall be primed and painted.

1. Factory applied enamel finish, color as selected by the Architect from manufacturer's standard color chart.

H. Manufacturers: Vulcan Model DV, Embassy Industries, Rittling, Slant/Fin, Sterling, Trane.

2.5 ELECTRIC UNIT HEATERS

A. Horizontal Unit: Construct casing of steel, phosphatized inside and out, and finished with baked enamel. Provide motor-mounted panel, minimum of 18 gauge steel. Fabricate casing to enclose heater, louvers and fan blades. Provide individually adjustable louvers for air diffusion.

B. Construct fans of aluminum and factory balance.

C. Metal sheath fin tube electric heating element.

D. Provide totally enclosed motors, with built-in overload protection, having electrical characteristics as scheduled.

E. Provide integral residual heat sensor to continue fan operation until element temperature fall below preset point.

F. Manufacturers: American Air Filter, Electromode,Trane, Berko, Indeeco, TPI/Markel, Q-Mark.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION OF UNIT HEATERS

A. Install heaters in accordance with manufacturer's installation instructions.

B. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.

C. Hang unit from building substrate.

D. Protect units with protective covers during balance of construction.

3.3 INSTALLATION OF CABINET HEATERS

A. Install cabinet heaters in accordance with manufacturer's installation instructions.

B. Locate cabinet heaters as shown on the drawings. Coordinate with other trades.

C. Protect units with protective covers during balance of construction.

3.4 CONVECTORS AND FIN TUBE RADIATION

A. Handle and install units in accordance with manufacturer's written instructions.

B. Support units rigidly so they remain stationary at all times. Crossbracing or other means of stiffening shall be provided as necessary. Method of support shall be such that distortion and mal-operation of units cannot occur.

C. Installed height shall be in accordance with manufacturer's recommendations.

D. Fin tube radiation: Enclosures shall be run continuously, wall-to-wall.

3.5 DUCT HEATING COILS

A. Install in accordance with manufacturer's recommendations.

B. Coil casing dimensions shall not be less than approach duct dimensions.

C. Comb fins if damaged. Install safing to eliminate air bypass or leakage at coil sections.

3.6 INSTALLATION OF ELECTRIC HEATERS

A. Install heaters in accordance with manufacturer's installation instructions.

B. Uncrate units and inspect for damage. Verify that nameplate data corresponds with unit designation.

C. Hang unit from building substrate.

D. Protect units with protective covers during balance of construction.

E. Perform field mechanical balancing in accordance with Section 23 0950: TESTING AND BALANCING OF MECHANICAL SYSTEMS.

END OF SECTION 23 0725

SECTION 23 0730

TERMINAL HEATING AND COOLING EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 23 0200 for HVAC General Provisions

C. Refer to Section 23 0210 for HVAC Basic Materials & Methods.

1.2 DESCRIPTION OF WORK

A. This Section includes work necessary and/or required and materials and equipment for construction of a complete system. Such work includes, but is not limited to the following:

1. Unit Ventilators (Heating & Cooling)

1.3 REFERENCE STANDARDS

A. Refer to Section 23 0200 for a general description of requirements applying to this section.

B. Media type air filters shall comply with U.L. Standard 900.

1.4 QUALITY ASSURANCE

A. Refer to Section 23 0210 for a general description of requirements applying to this Section.

1.5 SUBMITTALS

A. Submit shop drawings in accordance with Section 23 0200.

B. Submit shop drawings and descriptive date for all equipment specified in this section.

1.6 SUBSTITUTIONS

A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be completely responsible to comply with all requirements on all contract documents. This shall include, but not limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items provided by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements. In addition, the following special guarantee applies:

1. Each compressor unit shall be provided with manufacturer's five (5) year warranty.

PART 2 – PRODUCTS

2.1 UNIT VENTILATORS

A. Unit frames shall be of unitized, welded construction, with structural elements aligned in an assembly jig prior to welding, to insure proper dimensions, rigidity, and squareness. Frames assembled with mechanical fasteners shall not be acceptable.

B. Internal sheet metal parts shall be constructed of galvanized steel to inhibit corrosion.

C. Exterior cabinet panels shall be fabricated from furniture grade steel of not less than 16-gauge steel with no sharp edges and no unsightly screw heads and shall receive an electro-statically applied powder paint, and be oven baked with environmentally friendly thermosetting urethane powder finish to provide a high quality appearance. Finish color shall be selected by Architect from manufacturer's standard colors.

D. The interior areas of the unit ventilator shall be insulated for sound attenuation and to provide protection against condensation of moisture on or within the unit. The unit shall be provided with an ultra-quiet sound package consisting of acoustically marched low speed fans to fan housing, sound barrier insulation material (non-fiberglass) adhere to the bottom underside of the unit top panel, sides of the fan section and sound absorbing insulation (non-fiberglass) material applied to the unit front panel.

E. Units shall be constructed so that testing and troubleshooting can be accomplished in the end pockets of operating units, without affecting the normal air flow patterns through the unit.

F. Each unit shall be provided with a non-fused power interrupt switch that disconnects the main poiwer to the unit for servicing or when the unit is to be shut down for an extended period of time. The fan motor and controls shall have the hot line(s) protected by factory installed cartridge type fuse(s).

G. The manufacturer shall have published caraloged sound data available for the engineer's review. Sound data shall have been conducted using a qualified reverberant room per ANSI S1.31 and ANSI S12.32. Sound test data shall be based on standard CFM at standard air (fixed density of air at 70°F) in accordance with ARI procedures based upon ARI 350. The engineer shall have the right to reject equipment not conforming to the specified manufacturer's sound data, as a minimum. Sound levels shall not exceed those shown below:

Octave Band and Center Frequency (Hz)								
UNIT CFM	Speed	2 125	3 250	4 500	5 1000	6 2000	7 4000	8 8000
750	High	57.4	51.8	52.5	52.6	51.2	46.9	35.2
	Med.	50.1	44.9	45.6	44.8	42.8	34.2	19.9
	Low	45.6	40.4	40.8	39.1	35.7	24.4	12.0
1000	High	57.0	52.8	53.9	53.7	51.5	46.8	35.9
	Med.	52.9	48.6	50.2	49.6	46.5	40.1	27.9
	Low	49.4	45.4	47.0	45.5	42.0	33.6	20.7
1250	High	62.4	55.2	55.7	55.3	54.4	49.7	38.5
	Med.	59.3	52.1	52.5	51.7	50.4	44.0	31.8
	Low	55.6	48.6	49.1	47.2	45.6	37.1	24.0
1500	High	63.8	56.6	58.0	58.2	56.4	52.4	41.9
	Med.	58.4	51.3	52.7	52.4	49.5	43.5	30.5
	Low	54.8	47.6	49.4	47.5	44.2	36.2	21.5
Sound Power Levels - dB re 10-12 watt								

- Test data based on valve control unit having 3 rows of coil and no outdoor air. Sound power data may vary based on the type of unit, number of coil rows and other external factors.

2.2 FLOOR UNITS

A. Floor mounted units shall have an integral pipe tunnel for convenient crossover pf piping and a built-in metal wire raceway from right end compartment to left end compartment to contain any line voltage electrical wiring separate from the air stream. Line voltage wiring shall not be touchable in the air

stream of the unit during normal maintenance procedures of oiling bearings or motors. Unit shall come standard with a factory installed and wired disconnect switch.

B. Unit top surface shall be supplied with a charcoal bronze textured finish, to resist scuffing, reduce glare and help hide fingerprints. Unit top shall have two access doors, one at each end (for access to motor and bearings for easy servicing). The front and ends shall be available in a selection of architecturally pleasing colors by the manufacturer, for selection by the Architect.

C. Unit discharge grille shall be constructed of continuous rounded edge steel bars to provide 10 degree vertical deflection. A ¼" painted, galvanized mesh screen shall be provided beneath the discharge grille to protect against objects being dropped through the discharge grille.

D. The unit top and grille shall be aof a modular construction so that it is removable for service and maintenance.

E. The unit front surface shall be comprised of three separate removable panels. The controls and piping shall be accessible without removing the entire front panel. Panels shall be secured to the unit with recessed, tamper resistant, Allen head fasteners. Slots for flat head screwdrivers shall not be acceptable as tamper resistant.

F. An extended cabinet depth unit, 21-7/8" deep, shall incorporate a partial adapter back with an open pipe tunnel with the same features of the standard cabinet depth units with the additional capability of bringing in fresh air from 1" to 13" from the floor. The outdoor fresh air enclosure shall be insulated to form a thermal barrier. The vertical and horizontal insulated fresh air enclosure metal extensions shall have a 1" wide compressible gasket to form an airtight seal between the wall and the unit. The top shall be supported with metal braces. The space between the top extension and insulted fresh air enclosure shall arrive from the factory without the requirement to be field modified for the installation of piping or moving of a partition that would require re-sealing. A field removable horizontal support plate between the unit bottom and top shall not be acceptable.

2.3 COILS

A. Coil assembly shall be of a modular construction so that it is removable from the front of the unit.

B. All coils shall be installed in a draw through position to assure uniform air distribution over the full-face area of the coil, and an even unit discharge temperature.

C. All heating and cooling coils shall be constructed with copper tubes and mechanically bonded aluminum corrugated plate type fins. All coils shall have aluminum individual unshared fin surfaces. An air break shall exist between coils.

D. Water heating and cooling coils shall be furnished with a threaded drain plug at the lowest point and a manual air vent at the high point of the coil. A factory installed low temperature freezestat shall be provided on the leaving edge of the water heating coil in a wave-like configuration to sense multiple locations and shall react to possible freezing conditions. The unit mounted controls shall incorporate this device.

2.4 DRAIN PAN

A. All units shall have a drain pan constructed of corrosion resistant, composite material and shall be insulated. A drain outlet shall be provided on both ends of the pan. The drain hand of connection shall be easily field reversed by relocating the cap to the opposite end.

B. The drain pan shall be able to be sloped in either direction for proer condensate removal.

C. Drain shall be provided with a secondary, overflow drain connection on both ends of the pan.

2.5 FANS AND MOTOR

A. The fan and motor assembly shall be of a low speed design to assure maximum quietness and efficiency.

B. Fans shall be double-inlet, forward-curved, centrifugal type with offset aerodynamic blades. Fans and shaft shall be statically and dynamically balanced as an assembly in the unit before shipment.

C. Fan housing shall be constructed of galvanized steel incorporating logarithmic expansion for quiet operation. Fan and motor assembly shall be of the direct drive type. Belt drive fans shall not be allowed.

D. Motors shall be 155 volt, single phase, 60 Hz, NEMA permanent split capacitor (PSC), plug-in type with auto reset internal thermal overload device designed specifically for unit ventilator operation. Motors shall be located out of the conditioned air stream.

E. All components of the fan/motor assembly shall be removable from the top of floor-mounted units.

F. Units shall have sleeve type motor and fan shaft bearings, and shall not require oiling more than annually. All bearings shall be located out of the airstream. Bearings in the air stream are not acceptable.

G. Motor speed shall be controlled by factory mounted multi-tap transformer for three (3) speeds, HIGH-MEDIUM-LOW-OFF (not accessible from the exterior of the unit). Fan motor and controls shall each have hot leg protected by a factory installed cartridge fuse.

2.6 FACE & BYPASS DAMPER

A. Each unit shall be provided with a factory-installed face and by-pass damper, constructed of aluminum. The long sealing surfaces of the damper shall seal positively against stops fitted with extruded EPDM rubber seals. Face and bypass dampers without sealing edges to prevent air bypass shall not be acceptable. The damper ends shall have blended mohair seals along the ends glued to the damper end for a positive seal. Plastic clip-on brush ends seals shall not be acceptable as an end seal. The unit design shall incorporate the face and bypass damper to prevent coil surface wiping and be before the fan in a draw-thru configuration. The face and by-pass damper shall be arranged to have a dead air space to minimize heat pick-up in the by-pass position.

2.7 OUTDOOR & ROOM DAMPERS

A. Each unit shall be provided with separate room air and outdoor air dampers.

B. The room air damper shall be two-piece, double-wall construction fabricated from aluminum, and be counterbalanced against backpressure to close by gusts of wind pressue, thereby preventing outdoor air from blowing directly into the room.

C. The outdoor air damper shall be two piece, double wall construction fabricated from galvanized steel, with ½” thick, 1-1/2 lb density glassfiber insulation encapsulated between the welded blade halves for rigidity and to inhibit corrosion. The outdoor air damper shall have additional foam insulation on the exterior surface damper blade and on the ends of the outdoor air chamber. A single blade damper, which can be twisted and will leak air, will not be considered.

D. Dampers shall be fitted with blended mohair seals along all sealing edges. Pressure adhesive sponge neoprene or plastic clip-on brush type sealers for damper seals are not acceptable. Rubber type gasket using pressure adhesive for fastening to metal and exposed to the outside air is not acceptable.

E. Dampers shall use the turned-metal principle on long closing ends with no metal-to-metal contact for proper sealing.

F. The damper shaft shall be mechanically fastened to the blade, and shall operate in bearings made of nylon or other material which does not require lubrication.

2.8 FILTER

A. Each unit ventilator shall be equipped with a one-piece filter located to provide filtration of the return air/outdoor air mixture, in lieu of separate filters for each air stream. The entire filter surface must be useable for filtration of 100% room air or 100% of outdoor air. The filter shall be easily accessible from the front, and removable in one piece without removal of the unit return air damper stop. The unit shall ship with a factory installed 1" think fiberglass, single-use type.

B. Spare filters shall be:

1. 1" thick fiberglass, single-use type.
2. 1" thick permanent wire mesh washable
3. 1" thick permanent metal frames with replaceable media.

2.9 CONTROL COMPONENTS

A. The unit ventilator shall come with a factory installed pre-wired control package (called DigitalReady) pf Direct Digital Control (DDC) control components which facilitates field hook up of DDC Unit Ventilator Controllers (UVC) by others which are compatible with the factory installed sensors and actuators and capable of providing standard ASHRAE II cycle control sequence. Electrical wiring shall be isolated from the airstream. It shall be the entire responsibility of the Automatic Temperature Control (ATC) supplier to ensure the controls operate correctly and protect the unit. DigitalREady shall consist of the following components which are factory wired and powered:

1. 75 VA 24-volt NEC Class 2 transformer (50 VA or less is not acceptable) for 24-volt power supply with a complete 24-volt power wiring harness terminating in the left-hand end compartment at three 10-pole Europa type 16 awg terminal blocks rated for 10 amps at 300 volts.
2. Terminal strips hooked up with the fan motor start/stop relay
3. A factory installed Low Air Temperature Limit (Freezestat)
4. Unit mounted 10K NTC (Negative Temperature Coefficent) and 1K PTC (Positive Temperature Coefficient) Discharge Air Temperature Sensors.
5. Unit mounted 10 K NTC and 1 K PTC Outdoor Air Temperature Sensors
6. 24 VAC powered wired to the damper actuators
7. Direct coupled, proportional control 0 to 10 Vdc, or 4 to 20 mA), 35 inch-ounds or torque Outdoor Air/Return Air Damper Actuator that spring-returns the outdoor air damper shut upon a loss of power
8. Direct coupled proportional control (0 to 10 Vdc, or 4 to 20 mA) Face and Bypass Damper Actuator, non-spring returned
9. Terminal locations for 24-volt power to one or two End of Cycle valves (by ATC control contractor)
10. Direct coupled floating point (tri-state) Modulating Valve Actuator, non-spring returned
11. Terminal connectors for interface with a DDC UVC Controller (by ATC control contractor).

2.10 CONTORL FUNCTIONS

A. The Unit Ventilator Digital Controller (here after referred to as UVC) shall support ASHRAE Cycle II operation. The control cycle shall be used to maintain the required minimum amount of ventilation

whenever possible, which can be increased during normal operation for economizer cooling, but can also be reduced to prevent excessively cold discharge air temperatures.

B. Cool Mode

C. Water Coil Leaving Air Temperature Thermostat (Freezestat)

1. A normally-closed Low Temperature Thermostat (Freezestat) shall be factory provided to detect low leaving air temperature conditions on the unit indoor air hot water coil. This thermostat shall be mounted on the discharge airside of the units hot water coil. The low temperature thermostat cutout shall be 38°F (38°C) +/-2 and the cut-in shall be 45°F (38°C) +/-2. When the low temperature thermostat detects low leaving air temperatures (contact opens) the following shall occur during Face and Bypass Heating operation: when the freezestat cuts-out the OAD shall close immediately, the heating EOC valve shall fully open immediately, any mechanical cooling shall be de-energized immediately. If heating is required, the Face and Bypass damper shall modulate, as needed, otherwise the Face and Bypass damper shall go to 100% bypass, auxiliary heat may be used as needed. When the Freezestat resets or cut-in the UVC shall return to normal operation. If the freezestat trips more than 3 times in one ten day period, the system shall have to be manually rest.

2.11 BASIS OF DESIGN

A. Dakin

B. Acceptable Alternates

1. With prior approval only. Submit detailed listing of all variations in form, fit, or function, in addition to specified submittal data for approval before bidding. Equipment or manufacturers not listed in this specification shall not be acceptable or approved for installation. Provide required information as specified in Section 01350.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install all equipment in strict accordance with manufacturer's instructions and so as to be compatible with the intent of the respective system performance requirement.

B. The system Integrator/Controls contractor shall be responsible for the integration of all factory provided unit mounted controls and unit communications as required/specified for unit integration into the Building Automation System and proper unit operation.

C. Contractor shall clean each unit and accessory section of construction duct and debris, prior to turning systems over to the Owner.

D. Contractor shall install clean filters in each unit at time of system commissioning, and shall delver to the Owner one complete set of spare filters, and one spare motor of each type used in the project.

E. System Integrator/Controls contractor shall be responsible for the integration of all factory provided unit mounted controls and unit communications as required/specified for unit intergration into the Building Automation System and proper unit operation.

F. Installer shall engage the services of manufacturer's factory trained service technician to provide check, test, and start-up of each unit ventilator system.

G. Contractor shall provide one-year warranty for furnishing parts and labor for replacing any part of the unit ventilator or accessory sections, which becomes defective in operation. Unit ventilator manufacturer's representative shall maintain a local stock of replacement parts to support the systems specified herein.

H. Contractor shall submit a completed "Check and Test and Start Sheet" for each Unit Ventilator installed for verification of proper installation and start-up.

END OF SECTION 23 0730

SECTION 23 0760

AIR HANDLING EQUIPMENT

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. The general provisions of the contract, including the conditions of the contract (General, Supplementary and other Conditions, if any) and Division 1 as appropriate, apply to the work specified in this section.

B. Refer to Section 23 0200 for HVAC General Provisions

C. Refer to Section 23 0210 for HVAC Basic Materials & Methods.

D. Refer to Section 23 0450 for Refrigeration Equipment – HVAC.

E. Refer to Section 23 0615 for Airflow Measurement Devices.

1.2 DESCRIPTION OF WORK

A. This Section includes work necessary and/or required and materials and equipment for construction of a complete system. Such work includes, but is not limited to the following:

1. Rooftop Packaged Air Conditioning Unit

1.3 REFERENCE STANDARDS

A. Refer to Section 23 0200 for a general description of requirements applying to this section.

B. AMCA Standards 210 and 300 for fans.

C. ARI Standard 410, ASHRAE Standard 33 for Heating and Cooling Coils.

D. ASHRAE Standard 52.2 and U.L. Standard 900 for media type air filters.

E. AMCA Standard 511 and 500D for Air Control Dampers.

F. AMCA Standard 611 and 610 for air flow measurement stations.

G. ARI Standard 1060 and ASHRAE Standard 84 for Air-to-Air Energy Recovery Equipment.

H. ARI Standard 260 and 430 for Air Handling Units.

1.4 QUALITY ASSURANCE

A. Refer to Section 23 0210 for a general description of requirements applying to this Section.

B. Whenever a variable frequency PWM drive is installed to control an AC motor, a maintenance-free, circumferential, conductive micro fiber shaft grounding ring shall be installed on the AC motor drive end to discharge shaft currents to ground. Recommended part: AEGIS SGR™ Bearing Protection Ring, as made by Electro Static Technology. Install in accordance with the manufacturer's written instructions.

1.5 SUBMITTALS

A. Submit shop drawings in accordance with Section 23 0200.

B. Submit shop drawings and descriptive date for all equipment specified in this section.

1.6 SUBSTITUTIONS

A. The listed equivalent or substituted manufacturers along with the bidding related contractor shall be

completely responsible to comply with all requirements on all contract documents. This shall include, but not limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades, including all required ancillary items provided by other trades. If the manufacturer or related bidding contractor does not comply with these requirements, this Contractor shall be responsible for any and all additional costs associated with the changes required by other trades.

1.7 WARRANTY/GUARANTEE

A. All work and materials are subject to the general warranty as described in the General Conditions of the Contract and in Division 1, General Requirements. In addition, the following special guarantee applies:

1. Each compressor unit shall be provided with manufacturer's five (5) year parts and labor warranty.

PART 2 – PRODUCTS

2.1 ROOFTOP PACKAGED AIR CONDITIONING UNIT

A. Provide a one-piece, curb-mounted, air-to-air electric packaged cooling unit. Unit shall be completely assembled, and tested complete with refrigerant charge and ready to operate. The total unit shall be UL listed and carry a UL label.

B. Unit compressor(s) shall be welded, fully hermetic with crankcase heater(s) and suitable vibration isolators. The standard unit shall be capable of operating down to 45 degrees F (OA) on a cooling cycle. Compressors shall have a 5-year parts and labor warranty.

C. Indoor and outdoor coils shall be of non-ferrous construction with aluminum fins mechanically bonded to seamless copper tubes with all joints brazed.

D. Indoor air fan shall be forward-curved, centrifugal. Motor shall have permanently lubricated bearings. Outdoor fan shall be of the propeller type with direct driven, totally enclosed, permanently lubricated motor.

E. Unit cabinet shall be constructed of 14-gauge galvanized steel, bonderized and coated with a baked enamel finish. Cabinet interior shall be insulated with 1/2" thick neoprene coated fiberglass. Cabinet panels shall be easily removable for service to all operating components. A condensate drain for the indoor coil shall be provided. Condenser coils and fan discharge shall be protected by heavy duty wire guards.

F. The cooling system shall be protected with low-pressure switch, loss- of-charge protection, indoor coil freezestats and current and temperature sensitive overload devices. Each of these devices shall be wired to prevent compressor restart until reset at the thermostat.

G. Cabinet shall contain suitable openings for routing of all utility connections.

H. Filters: 2" thick disposable type, MERV 8. Provide two (2) sets.

I. Compressor shall not short cycle as a result of a rapid change in thermostat setting.

J. Roof curb shall be of the same manufacture as unit and shall include an insulated panel under compressor section to prevent condensation forming on the bottom. Roof curb shall be a minimum of 16" high.

K. Provide economizer control which shall include R.A. and low-leak O.A. dampers and barometric relief damper, outdoor air filters and hood, and fully modulating electric control system with O.A. thermostat and mixed air thermostat. Economizer control shall be capable of introducing up to 100% outdoor air. The control changeover from mechanical cooling to economizer operation shall be fully automatic thru an adjustable outdoor air changeover thermostat. Economizer shall be integrated type

capable of simultaneous compressor and economizer operation for maximum benefit of outdoor air.

L. Electrical: Electrical features shall include single point power feed termination, unit-mounted lockable disconnect, internal circuit breaker type overload protection, starters, 24 VAC control transformer and fusing.

M. Thermostat:

1. Option: Provide conventional thermostat interface with marked positions on unit terminal strip.
2. Factory mount/wire the DDC controller and discharge air sensor furnished by the BAS as part of the work of Section 23 0900.

N. Manufacturers: York/Johnson Controls, Trane, Carrier, Daikin McQuay

1. Any listed equivalent manufacturer and the Mechanical Contractor shall be completely responsible to comply with all requirements on the contract documents. This shall include, but not be limited to, space requirements, code clearances, the type, horsepower, capacities, number and size of services required from other trades.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which equipment is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

B. Install in accordance with manufacturer's recommendations. Unit and all component sections shall be properly supported and vibration isolated.

C. When unit has been used during the construction period, the following shall be done prior to balancing and adjusting of system:

1. Permanent filters shall be washed as required to obtain clean condition and coated with proper adhesive.
2. Throwaway type filters shall be replaced with new. The Mechanical Contractor is responsible to provide and install new throwaway filters upon project's substantial completion. The Mechanical Contractor shall notify Owner's maintenance personnel prior to installation.

3.2 INSTALLATION

A. Verify that coils, filters, motors, drives and other components are matched with the proper unit.

B. Assemble unit components following manufacturer's instructions for handling, testing and operation. Repair damaged galvanized areas, and paint in accordance with manufacturer's written recommendations.

C. Vacuum clean interior of units prior to operation.

D. Repair air leaks from or into casing that can be heard or felt during normal operation.

E. Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.

F. Support: Install and secure roof curb to roof structure, in accordance with National Roofing Contractor's Association (NRCA) installation recommendations and shop drawings. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing.

G. Perform field mechanical balancing in accordance with Section 23 0950: TESTING AND BALANCING OF MECHANICAL SYSTEMS.

H. The Mechanical Contractor shall own as part of his work, the following:

Provide one (1) additional drive set, if necessary, to obtain final design balancing requirements. The Mechanical Contractor shall coordinate with Balancing Firm and equipment manufacturer for drive selection, including belts and pulleys.

I. Provide certified factory start-up and written report on all units.

3.3 AUTOMATIC TEMPERATURE CONTROLS

A. Coordination of control work with the BAS shall include, but not be limited to, the following items as described in Section 23 0900: ATC.

B. Constant volume rooftop units:

1. The following items shall be provided by the equipment manufacturer:

a. Motor starters and overload protection.

b. Control transformers.

c. Dampers and damper motors.

d. Terminal blocks for all wiring connections between equipment and control devices.

e. Manual reset freeze stat.

f. DDC Controller

2. The following items shall be furnished, field mounted, and wired by the BAS Contractor:

a. Discharge air temperature sensor.

b. Discharge humidity sensor.

c. Heating coil discharge air temperature sensor.

d. Manual reset freezestat (supplied by ATC).

C. The factory mounted DDC controllers shall be fully programmed with factory approved applications. Any modifications to these programs shall be done by factory trained personal or as approved by the DDC controls and unit equipment manufacturer.

The unit equipment manufacturer shall provide coordination for start-up, check-out, and test of the factory mounted DDC controllers and network devices including the protocol translator. Any hardware and software necessary including labor shall be provided by the unit equipment manufacturer.

The unit DDC controllers shall be networked to a standard protocol translator or gateway so system points shall be available for communications and control from the Building Automation System (BAS)/Automatic Temperature Controls (ATC) System. The protocols available from the protocol translator to the BAS/ATC System shall be BACNET (MSTP), LON or N2.

System points shall be configured to the BAS/ATC System by the BAS/ATC System Contractor. The mapping of points to the BAS/ATC front-end/PC shall be done by the BAS/ATC Contractor. Any software or hardware necessary including labor to accomplish this work shall be provided by the BAS/ATC System Contractor.

END OF SECTION 23 0760

SECTION 23 0900

AUTOMATIC TEMPERATURE CONTROL

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Section 23 0200 and drawings are hereby made a part of this section as fully as if repeated herein.

B. The Mechanical Contractor shall coordinate with the work of Division 26 and the Fire Alarm System vendor for locations and mounting of all duct smoke detectors. These devices are shown on the Mechanical Drawings for reference only to show the intent of the work. All locations shall be determined based on approved shop drawings from the Fire Alarm System vendor and the Contractor for the work of Division 26, Electrical.

1.2 DESCRIPTION OF WORK

A. Provide labor, material and supervision necessary to install direct digital system of temperature controls to control all HVAC Systems, associated components and accessories as described herein.

1.3 SUBMITTALS

A. Submit shop drawings and manufacturer's data sheets of all equipment.

B. Submit manufacturer's certificates of conformance with applicable codes.

C. Furnish point-to-point diagram of automatic temperature control system approval, including heating, ventilating and air conditioning equipment wiring diagrams where temperature control connections are required.

D. Provide ten (10) copies of submittal data within thirty (30) days of contract award.

E. Submittal shall consist of:

1. System Architecture showing all digital and pneumatically actuated devices.
2. Equipment lists of all proposed devices and equipment including data sheets of all products.
3. Valve, damper and well and tap schedules showing size, configuration, capacity and location of all equipment.
4. Data entry forms for initial parameters. Contractor shall provide English listing of all analog points with columnar blanks for high and low warning limits and high and low alarm limits, and a listing of all fan systems with columnar blanks for beginning and end of occupancy periods; and samples of proposed text for points and messages (for at least two systems of at least 15 points total) including sample 480 character alarm message. All text shall be approved prior to data entry.
5. Wiring and piping interconnection diagrams including panel and device power and sources.
6. Sketches of all graphics.

1.4 QUALITY ASSURANCE

A. Insure that all work and equipment is installed in accordance with manufacturer's warranty requirements.

B. Provide adequate supervision of labor force to assure that all aspects of specifications are being fulfilled.

C. The system shall be engineered, programmed and installed by personnel trained and regularly employed by the control's manufacturer.

D. Supplier shall have technical support to promptly respond within 24 hours or less to service calls to the site with technical staff, spare parts inventory and test and diagnostic equipment.

E. Codes and Approvals:

1. The complete system installation shall be in strict accordance with national and local electrical codes. All devices designed for or used in line voltage applications shall be UL listed.

   a. All microprocessor based devices shall be UL916 listed.

   b. All electrical environmental control and monitoring devices shall be UL429 and/or UL873 listed.

2. All electronic equipment shall conform to the requirements of FCC regulation Class B, Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

3. The complete system shall conform to ANSI/ASHRAE Standard 135-2012, BACNET.

F. All system components shall be designed and built to be fault tolerant.

1. Provide satisfactory operation without damage at 100% above and 85% below rated voltage and at +3 Hertz variation in line frequency.

2. Provide static, transient, and short circuit protection on all inputs and outputs. Communication lines shall be protected against incorrect wiring, static transients and induced magnetic interference. Bus connected devices shall be A.C. coupled or equivalent so that any single device failure will not disrupt or halt bus communication.

1.5 ELECTRICAL WIRING

A. All electrical wiring, components and accessories in connection with the Automatic Temperature Control System shall be furnished and installed by the control manufacturer.

1. Electrical Contractor shall provide all wiring to duct smoke detectors.

2. Unless stated otherwise in the design documents, the ATC Contractor is responsible for providing control power to all valves, actuators, devices and components within the DDC System regardless of the selected voltage of those devices. This also includes all 120 volt power circuits required for devices, panels and control equipment.

3. The ATC Contractor shall be responsible for providing the control interface between terminal unit condensate pumps and their respective units at the required voltage of these devices in order to shut down the terminal unit in the event of high water level in the condensate pump receiver.

B. Control wiring shall include all wiring necessary to interface with new controls, shall also include electric and electronic devices such as freezestats, electronic sensors, relays, flow switches and controlled devices such as valve and damper operators, electric actuated devices, new. Pilot devices such as ON/OFF switches and thermostats installed in series with line voltage circuits shall be considered to be control wiring.

1.6 AUTOMATIC TEMPERATURE CONTROL

A. Provide an extension of the existing Johnson “METASY’S” controls and Trane “NIAGRA” head end DDC System of automatic temperature control which shall be as manufactured by Alerton Technologies, Inc., as installed by Advanced Power Control, Inc., Johnson Controls, Inc., as installed by Modern Controls, Inc., Staefa Control System as installed by Automatic Control Systems, Inc., Automated Logic Corp., as installed by Radius Systems, Andover Controls, Inc., as installed by Tri-M Controls, Inc., and Trane Controls The system shall be complete in all respects including labor,

materials, equipment and services necessary.

B. All electrical wiring in connection with the installation of the automatic temperature control system shall be furnished and installed under the direct supervision of the control manufacturer.

PART 2 – PRODUCTS

2.1 TEMPERATURE SENSORS

A. Solid state room sensors shall be of the wire wound resistance type element. Sensors shall be equipped with visual readout and adjustment. Sensors shall be of the completely solid state type with no moving contacts. Printed circuit board under thermostat cover shall contain a low mass resistance type setpoint dial and amplifier. Provide test points for measuring output voltage. Sensors shall be direct or reverse acting as required for the sequence of operation.

B. Sensors shall provide the application for night setback override.

C. Sensors shall be mounted at ADA height (48” above floor).

2.2 SMOKE DETECTORS

A. Duct type ionization smoke detectors shall be furnished by the Electrical Contractor and installed by the Mechanical Contractor in the supply and return air stream. The Electrical Contractor shall provide wiring from each detector to the Fire Alarm System panel.

B. The Electrical Contractor shall provide an alarm output signal from the FAS panel to the BAS for unit shutdown.

2.3 ACTUATORS

A. Electronic actuators shall be sized to operate their appropriate dampers and valves with sufficient reserve power to provide smooth modulating action or two-position action as specified.

B. Provide integral, auxiliary switches for direct coupled actuators to indicate when a desired position is reached or to interface additional controls for a specific sequence.

C. Align actuator with drive shaft, provide permanent mark to identify closed position of end device.

2.4 SENSOR TRANSMITTERS

A. Duct and immersion sensors shall have minimum spans as required to meet the temperature requirements. Duct sensors shall have sensing elements of sufficient length and accuracy to measure average duct temperature in each location.

B. Sensors shall be of corrosion resistant construction, tamperproof, suitable for mounting on a vibrating surface. Exposed capillaries shall be temperature compensated, and armored or installed in protective tubing.

C. All sensing elements for water pipe mounting shall be of the rod and tube type with linear output and shall be furnished complete with separable protecting wells filled with heat conductive compound. Sensors shall be factory calibrated and tamperproof. If easily adjustable sensors are provided, they shall be located inside metal enclosures with cylinder lock and key to prevent unauthorized setting.

D. Safety Devices: Provide the following:

1. Low limit, electric type, with 20’ long serpentine element, with manual reset, set for 37°F for “freeze” protection and 55°F for fan discharge application, unless otherwise noted.

2. Air and water duty flow switches: Differential pressure type for fan and pump status.

3. Carbon monoxide sensor/transducer/meter shall be analog type, requiring no field or periodic calibration, suitable for wall mounting.

a. Microprocessor controlled digital display of 0 to 250 ppm CO.

b. Analog output of 4 to 20 milliamps.

c. UL listed housing, suitable for an operating environment of 0 to 125 F/ 10 to 90% RH.

d. Repeatability of +/- 10% at 50 ppm; linearity of +/- 10%.

e. Power input of 3.5 watts at 24 VAC.

f. Make: Macurco inc. model CM-2B.

g. Manufacturers: Air Test Technologies, Inc., Macurco, Rotronic Instrument Corp., Vaisala, Inc.

4. Make-up Water Monitoring System (Typical for chilled water & hot water heating system):

(Manufacturer's Rep. 888-397-5353)

a. Monitor data as received by flow meter on cold water make-up system. When flow exceeds 10 gal./1 min (adj.), ATC system to close normally open solenoid valve, alarm system (provide call out), shutdown boilers, pumps, chillers, etc., associated with respective system.

b. Flow sensor, consisting of a removable flow sensor mounted in cast bronze housing, available in ½" to 1-1/2" pipe size. Sensor shall be rated for a flow range of 0.5 to 15 feet per second, 220°F max., 400 psig at 100°F max. pressure; Nylon impeller, Pennlon bearing, tungsten carbide shaft, PPS housing and EPDM seals. Manufacturer: Kele Model 250B, Data Industrial Series 250BR.

c. Programmable analog flow transmitter shall be a loop-powered device that converts a flow sensor signal into a linear 4 – 20 mA signal. Electronic signal dampening, computer programmable, compact size in a metal enclosure. Power input, 9-35 VDC/0-1 kHz, 75 ohms at 24 VDC, accuracy of 0.1% of full scale. Manufacturer: Kele Model 310-02, Universal Flow Transmitter Model UFT-1.

6. Liquid Leak Detection System: Kele, Raychem, Trace Tek.

a. Mechanical float devices attached to or inserted within the auxiliary pan are not acceptable.

b. Sensor shall be activated when there is at least ¼ inch of water, but no more than ½ inch of water in the auxiliary pan.

c. Equal to Kele Model WD-1B water detector.

(1) Weatherproof cast aluminum enclosure with adjustable mounting feet.

(2) 11-27VAC/VDC, 60 Hz, SPDT alarm contacts.

(3) LED indicators for power (green) and alarm (red).

(4) Fully adjustable detection level.

E. HUMIDITY TRANSMITTERS

1. Units shall be suitable for duct, wall (room) or outdoor mounting. Unit shall be two-wire transmitter utilizing bulk polymer resistance change or thin film capacitance change humidity sensor. Unit shall produce linear continuous output of 4-20 mA for percent relative humidity (%RH). A combination temperature and humidity sensor may be used for zone level monitoring. Sensors shall have the following minimum performance and application criteria:

a. Input Range: 0 – 100% RH

b. Accuracy (%RH): +/- 2% (when used for enthalpy calculation, dewpoint calculation or humidifier control) or +/- 3% (monitoring only) between 20-90%RH at 77°F, including hysteresis, linearity, and repeatability.

c. Sensor Operating Range: As required by application.

d. Long Term Stability: Less than 1% drift per year.

2. Acceptable Manufacturers: Units shall be Vaisala HM Series, General Eastern, Microline, or Hy-Cal HT Series.

2.5 CONTROL VALVES

A. Valves shall be rated for a minimum of 150 percent (150%) of system operating pressure at the valve location but not less than 125 psig.

B. 2" and Smaller: Valves shall be bronze body with screwed or flared connections.

C. 2-1/2" and Larger: Valves shall be bronze or iron body, flanged.

D. Flow characteristics:

1. Three-way valves shall have a linear relation of flow vs. valve position.

2. Two-way valve position vs. flow relation shall be equal percentage for water flow control.

E. Maximum pressure drop through valve:

1. Modulating water flow control: 1/2 the pressure drop through the apparatus with maximum of 10 feet of water. Two position water valves shall be line size.

2. Two-position steam control: 20 percent (20%) of inlet gauge pressure.

3. Modulating steam control: 67 percent (67%) of inlet gauge pressure but not to exceed 45 percent (45%) of inlet absolute pressure (acoustic velocity limitation).

2.6 CONTROL DAMPERS

A. The ATC Sub-contractor shall furnish all the controlled dampers of the type and sizes indicated on the drawings for installation by the sheet metal Sub-contractor.

B. All 2-position control dampers shall be parallel blade and sized for minimum pressure drop, at the specified duct size.

C. All modulating dampers shall be opposed blade and sized for an effective linear air flow control characteristics within the angle of rotation and maximum pressure drops specified. Information shall be provided to the sheet metal Subcontractor for determining the proper duct reductions or baffles used.

D. Damper frames shall not be less than 16 gauge galvanized steel, formed with corner braces for extra strength, with mounting holes for enclosed duct mounting.

E. All damper blades shall be of not less than 16-gauge galvanized steel formed for strength and high velocity performance. Blades on all dampers must not be over 8" in width. Blades shall be secured to 1/2" diameter zinc plated axles by zinc plated bolts and nuts. All blade bearings shall be nylon or oilite. Blade side edges shall be sealed off against spring stainless steel seals. Teflon coated thrust bearings shall be provided at each end of every blade to minimize torque requirements and insure smooth operation. All blade leakage hardware shall be constructed of corrosion resistant, zinc plated steel and brass.

F. Dampers shall be suitable for operation between -40 and 200 degrees. The control manufacturer shall submit leakage and flow characteristics plus a size schedule for all controlled dampers.

G. All blade edges shall have inflatable seal edging that shall be rated for leakage less than 10 cubic feet per minute per square foot of damper area at a differential pressure of 4" of water when the damper is being held by a torque not to exceed 50 inert lbs. Leakage shall not exceed 1/2 of 1% of total flow.

H. Provide permanent mark or scribe end of drive shaft to align damper with actuator in closed position.

2.7 CONTROL CABINETS

A. Control cabinets shall be constructed of 18-gauge steel with locking hinged door. Unless otherwise specified, all controllers, electric relays, switches and other equipment furnished as part of the control system which are not required to be mounted on mechanical equipment, shall be cabinet mounted. The temperature indicators and switches shall be flush mounted on the door tagged with plastic labels. All electrical devices shall be wired to a numbered terminal strip and all devices shall be completely adjusted and checked for proper operation prior to shipment to job site. All wiring shall be numbered according to the control diagram.

2.8 MOTORIZED, ROTARY ELECTRIC CONTROL VALVES

A. Capacitor type reversible electric motor, gear train, limit switches and terminal block in a die-cast aluminum enclosure, NEMA 4, for outdoor locations.

B. Output shaft shall e nickel plated to prevent corrosion. Actuator shall be suitable for any mounting position, in ambient range from -40 to +150°F.

C. Actuator shall be sized against the operating torque required by the butterfly valve manufacturer.

D. Motor shall be fractional horsepower, permanent split capacitor type designed for 120 VAC, 1 phase supply.

E. Reduction gearing shall be hardened alloy steel, permanently lubricated. Two (2) adjustable CAM actuated end travel limit switches shall be provided to control direction of travel.

F. Actuator shall be provided with handwheel for manual override operation of the valve in the event of malfunction or power failure. Handwheel shall be permanently attached to the actuator.

G. When in manual, the electric drive mechanism shall be locked out for safety.

H. Actuator shall have visual indication of valve position.

I. Valve actuator shall be Raymond Control Systems MAR-100 Series with Dezurik high performance butterfly valve.

2.9 SEQUENCE OF OPERATION

A. Host Computer And Operator's Work Station (OWS)

1. All load programs, HVAC control programs, and program application features shall reside in the existing OWS.

2. Controls manufacturer shall provide subsequent levels of control capability to whatever extent necessary to achieve performance required for individual units in their respective local control panels (noted on drawings as LTCP-DDC).

3. Work with the Owner to establish occupied/unoccupied schedules and set points. Enter the schedules and set points into the system.

4. Work with the Owner to determine which points are to be trended and the frequency of sampling. Set up the agreed upon trend logs in the BAS.

B. Heating System Control:

1. This system consists of six (6) high efficiency condensing boilers B-1 thru B-6, each with

circulating pump P-1 thru P-6 respectively. Interface with the factory installed Cascade sequencing system furnished with the boilers.

2. The boilers' sealed combustion system shall be controlled by their integral controls which are all mounted, wired and tested at the factory prior to shipping. The boilers shall be activated/de-activated via the BAS based on outdoor air temperature, or via manual command at the OWS. Once activated, the boilers' Cascade sequencing system shall stage and modulate the boilers to maintain building loop temperature set point of 140°F, adjustable.
3. When the boiler is called to fire by its integral temperature controller, its respective circulating pump shall start, the sealed combustion system shall be activated and, when both water flow and combustion air is proven, the boiler shall be allowed to fire. The boilers' Cascade sequencing system shall alarm at the OWS if any boiler is called to fire and fails to start. This will be a general failure alarm which will require reset at the boiler(s) involved in the alarm condition.
4. Install the hot water supply temperature sensor in the building hot water loop piping as shown on the drawings. Interface with the boiler sequencing controls.
5. When the boilers sequencing system is activated by the BAS, all other existing pumps and changeover valves for the dual temp system shall be activated in accordance with the existing control system sequence.
6. The following items shall be displayed at the OWS:
   a. Graphical display of the boilers, pumps, and related piping.
   b. Boiler(s) activated/de-activated status per boiler.
   c. Boiler(s) failure per boiler.
   d. Outside air temperature, global.
   e. Hot water supply temperature at boiler header
   f. Hot water return temperature at boiler header
   g. Hot water supply temperature at building loop header.

C. Boiler Room Ventilation Control:

1. This system consists of ceiling exhaust fan, EF-1 and an outside air intake duct.
   a. Provide motor operated damper and actuator for control of outside air.
   b. Provide wall-mounted sensor on insulation base in the Boiler Room.
2. When space temperature rises above 80°F, adjustable, outside air damper shall open and exhaust fan shall start. If outside air damper fails to open, or exhaust fan fails to start, an alarm shall be sent to the OWS. Upon drop in space temperature below 80°F, the reverse shall occur.
3. Provide an end switch on the outside air damper to indicate position, open/ closed.
4. Provide current sensor on one leg of power to the exhaust fan to monitor operation.
5. Provide the following indications to the system:
   a. Room temperature.
   b. Damper position: open/closed.
   c. Fan status: on/off/alarm.

D. Boiler Room Heating Control:

1. This system consists of unit heater, EUH-1.
2. Wall-mounted sensor that is part of the ventilation sequence in article C shall activate the unit heater to maintain room temperature at 60°F, adjustable.
3. When space temperature is satisfied, unit heater shall be de-energized and its fan shall stop after residual heat sensor is satisfied.
4. Provide the following indication to the system:
   a. Room temperature.

E. Unit Ventilator with Cooling & Heating Coils

1. The sequence that follows is typical for all units. Each unit ventilator shall be controlled by an individual DDC controller. Fan speed shall be selected manually at each unit.
   a. Provide a wall mounted space temperature sensor and humidity sensor which shall be wired to the DDC controller.
   b. Provide a 2-way control valve and actuator for each water coil for installation in the room ATC control panel above the ceiling.
   c. Provide actuators for the face & bypass dampers, outside air/return air dampers, and relief air damper.
2. Morning warm-up:
   a. Based on the occupancy schedule in the OWS and prior to the switchover to occupied cycle, the fan shall energize, outside air damper shall remain closed until space temperature is restored to the occupied setpoint for either heating or cooling. When occupied temperature is reached, the outside damper shall open to occupied position. Return air damper shall move in unison.
3. Occupied Mode:
   a. During the programmed occupied mode, the supply fan shall run continuously with the outside air damper open to its minimum position. On a rise in temperature above the programmed cooling set-point, 75°F (adjustable), the 3-way control valve shall open full to the coil and the space sensor shall modulate the face and bypass dampers to maintain set-point. On a fall in temperature the reverse shall occur.
   b. On a drop in temperature below the programmed heating set-point, 70°F (adjustable), the 3-way control valve shall open full to the coil and the space sensor shall modulate the face and bypass dampers to maintain set-point. On a rise in temperature the reverse shall occur.
4. Unoccupied Mode:
   a. During the programmed un-occupied cooling and heating modes, the fan, coil control valves shall modulate to maintain the un-occupied set-points 85°F cooling/60°F heating (adjustable). The outside air damper shall remain closed, return air damper shall fully open, face & bypass dampers shall be fully open to coil face.
5. Provide a current sensor on one phase of power feeding the supply fan for status indication at the Operator's Terminal.
6. If the discharge temperature fails to rise to a programmed minimum temperature during a call for heating or cooling; a low and high temperature alarms shall be activated at the Operator's Terminal.

7. A low limit control (freeze stat) shall be installed in the unit. When tripped, the freeze stat shall function to de-energize the supply fan, damper actuators, and water control valves. When de-energized, the damper actuator shall spring return the outside air damper closed, open face & bypass dampers to full face; the water coil control valves shall spring return open to each coil. When the freeze-stat trips, an alarm shall be generated at the Operator's Terminal.
8. The following items shall be displayed at the Operator's Terminal:
    a. Space temperature.
    b. Space temperature set-point.
    c. Low Space temperature alarm.
    d. High Space temperature alarm.
    e. Discharge temperature.
    f. Global outside air temperature.
    g. Freeze stat status, normal/alarm.
    h. Commanded status of fan, off/on.
    i. Commanded position of control valves, open/closed.
    j. Commanded position of OA damper, open/closed.

F. Cabinet Heaters

1. The sequence that follows is typical for all units. Each cabinet unit heater shall be controlled by the BAS via a space temperature sensor.
    a. Provide a separate DDC controller and flat plate space sensor for each unit.
    b. Provide a 2-way, hot water control valve and actuator for installation in the unit by the Mechanical Contractor.
    c. Provide blocking valves on both supply and return piping connections to dual temperature piping system.
2. During the programmed occupied mode, the unit fan shall cycle. On a fall in space temperature below the programmed setpoint of 70°F, adjustable, the hot water coil control valve shall open. On a rise in temperature above setpoint, the valve shall close.
3. During the programmed un-occupied mode, the fan shall cycle and the hot water coil control valve shall open to maintain the programmed temperature setpoint of 60°F, adjustable.
4. If the discharge temperature fails to rise to a programmed minimum temperature during a call for heating, a low temperature alarm shall be activated at the OWS.
5. Provide a current sensor on one phase of power feeding the supply fan for status indication at the OWS.
6. During the cooling season, DDC controls to close supply and return blocking valves.
7. The following items shall be displayed at the OWS:
    a. Space temperature.
    b. Space temperature setpoint.
    c. Discharge temperature.

d. Commanded status of fan.

e. Operational status of fan via current sensor.

f. Low discharge temperature alarm.

g. Diagram showing the layout of the unit with major components and dynamic temperatures shown where temperature sensors exist in the system.

G. Radiation

1. The sequence that follows is typical for all radiation. Each shall be controlled by the BAS via a space temperature sensor.

   a. Provide a separate DDC controller and flat plate space sensor for each unit.

   b. Provide a 2-way, hot water control valve and actuator for installation in the unit by the Mechanical Contractor.

   c. Provide blocking valves on both supply and return piping connections to dual temperature piping system.

2. During the programmed occupied mode, on a fall in space temperature below the programmed setpoint of 70°F, adjustable, the hot water coil control valve shall open. On a rise in temperature above setpoint, the valve shall close.

3. During the programmed un-occupied mode the hot water coil control valve shall open to maintain the programmed temperature setpoint of 60°F, adjustable.

4. If the discharge temperature fails to rise to a programmed minimum temperature during a call for heating, a low temperature alarm shall be activated at the OWS.

5. Provide a current sensor on one phase of power feeding the supply fan for status indication at the OWS.

6. During the cooling season, DDC controls to close supply and return blocking valves.

7. The following items shall be displayed at the OWS:

   a. Space temperature.

   b. Space temperature setpoint.

   c. Low discharge temperature alarm.

   d. Diagram showing the layout of the unit with major components and dynamic temperatures shown where temperature sensors exist in the system.

H. Rooftop Unit/Duct Heating Coils

1. Provide an individual DDC Controller for unit and heating coils. The DDC Controllers shall be wired to space temperature sensors with setpoint adjustment and override switch. Provide a 24-volt control transformer and all sensors required for operation, monitoring, and control of the unit. Provide 2-way control valves and actuator for the duct heating coils for installation by the Mechanical Contractor.

2. During the programmed occupied mode, the supply fan shall run continuously.

   a. Provide motor operated damper and actuator for control of outside air for ventilation. Damper shall modulate open during the occupied mode and remain closed during the unoccupied mode.

b. Heating mode: On a fall in space temperature below the programmed heating setpoint of 70°F, adjustable, the heating coil control valves shall modulate open to the coil. On a rise in space temperature, the valve shall modulate closed.

c. Cooling mode: On a rise in space temperature above the programmed cooling setpoint of 75°F, adjustable, the controller shall activate the refrigeration cycle of the unit based on zone averaging of space sensors. On a fall in space temperature, the reverse shall occur.

3. During the programmed unoccupied mode, the fan shall cycle and the controller valves shall sequence the heating coil control valves and cooling unit to maintain the programmed unoccupied space temperature setpoints of 60°F (heating) and 85°F (cooling), all adjustable.

4. If the discharge temperature fails to rise to a programmed minimum temperature during a call for heating, a low temperature alarm shall be activated at the OWS. If the discharge temperature fails to fall to a programmed minimum temperature on a call for cooling, a high temperature alarm shall be activated at the OWS.

5. Provide a current sensor on one phase of power feeding the supply fan for status indication at the OWS.

6. When the low limit thermostat (freeze stat) trips, de-energize the supply fan, hot water control valves, and damper motors. When de-energized the damper motors shall spring return the all air dampers closed, the hot water control valve shall fail open to the coil. When the freeze stat trips, an alarm shall be generated at the OWS. Serpentine the element across the downstream face of the heating coil. Set at 40°F.

7. Interface with a common fire alarm input from the fire alarm system. The fire alarm contact shall be provided at the fire alarm panel by the Fire Alarm Contractor. The status of the alarm contact shall be communicated throughout the BAS. When the fire alarm contact indicates an alarm condition, the BAS shall de-energize the unit. When de-energized, the damper motor shall spring return the outside damper closed. Provide an alarm at the OWS to indicate fire alarm status.

8. The following items shall be displayed at the OWS:

   a. Global outside air temperature.

   b. Space temperatures.

   c. Space temperature setpoint.

   d. Discharge temperature.

   e. High and low limit discharge air setpoints.

   f. Commanded status of fan, supply.

   g. Operational status of fan via current sensor.

   h. Low discharge temperature alarm.

   i. High discharge temperature alarm.

   j. Low limit alarm.

   k. Diagram showing the layout of the unit with major components and dynamic temperatures shown where temperature sensors exist in the system.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install system and materials in accordance with manufacturer's instructions and roughing-in drawings, and details and drawings. Install electrical work and use electrical products complying with requirements of these specifications. Mount controllers at convenient locations and heights.

B. All wiring shall be properly supported and run in a neat and workmanlike manner. All wiring exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All piping and wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals. All wiring shall be in accordance with all local and national codes. Low voltage wiring for space temperature sensors, communication bus between terminal units, etc., above accessible ceilings in finished spaces on the floors may be plenum rated cable. Wiring in all other locations shall be installed in EMT conduit. All electronic wiring shall be #18 AWG minimum THHN and shielded if required, except standard network (Ethernet, LonWorks, etc.) cabling shall be as tested and recommended in lieu of #18 gauge twisted, #22 or #24 gauge is acceptable if used as a part of an engineered structured cabling system. The control manufacturer must submit technical and application documentation demonstrating that this cabling system has been tested and approved for use by the manufacturer of both the control system and the engineered structured cabling system.

C. Provide all sensing, control, and interlock wiring for the following:

System inputs and outputs

System communications

System power

System interlocks

Unit controls

D. The Control Manufacturer shall enter all computer data into the Host computer including all graphics, control programs, initial approved parameters and settings, and English descriptors. The Control Manufacturer shall maintain diskette copies of all data file and application software for reload use in the event of a system crash or memory failure. One copy shall be delivered to the owner during training sessions, and one copy shall be archived in the Control Manufacturer's local software vault.

3.2 DATA CONTROL (D/C) AND GRAPHICS SUMMARY

A. All hardware, custom software, application software, graphics, etc., necessary to accomplish the control sequences and display the graphics specified shall be provided as part of this contract. Provide all controllers, inputs, outputs, valves, dampers, actuators and flow meters required to provide the control and graphic data described. Provide software setpoints required for display in logical groups and graphics.

B. Each digital output shall have a software-associated monitored input. Any time the monitored input does not track its associated command output within a programmable time interval, a "command failed" alarm shall be reported.

C. Where calculated points (such as CFM) are shown, they shall appear in their respective logical groups.

D. Unless otherwise specified or approved prior to bidding, the primary analog input and the analog output of each DDC loop shall be resident in a single remote panel containing the DDC algorithm, and shall function independent of any primary or UC communication links. Secondary (reset type) analog inputs may be received from the primary network, but approved default values and/or procedures shall be substituted in the DDC algorithm for this secondary input if network communications fail or if the secondary input becomes erroneous or invalid.

3.3 ACCEPTANCE

A. The Control Manufacturer shall completely check out, calibrate and test all connected hardware and software to insure that the system performs in accordance with the approved specifications and sequences of operations approved.

B. Witnessed acceptance demonstration shall display and demonstrate each type of data entry to show site specific customizing capability; demonstrate parameter changes; execute digital and analog commands; and demonstrate DDC loop stability via trend of inputs and outputs.

3.4 MANUALS

A. The following manuals will be provided:

1. An Operators Manual shall be provided with graphic explanations of keyboard use for all operator functions specified under Operator Training.

B. Computerized printouts of all GPC data file including all point processing assignments, physical terminal relationships, scales and offsets, command and alarm limits, etc.

C. A manual shall be provided including revised as-built documents of all materials required under the paragraph "SUBMITTALS" on this specification.

D. Two Operators Manuals, and two As-Built Manuals shall be provided to the owner.

3.5 TRAINING

A. All training shall be by the BMCS contractor and shall utilize operators manuals and as-built documentation.

B. Operator training shall include three (3) four-hour sessions encompassing modifying text and graphics, sequence of operation review, selection of all displays and reports, use of all specified OWS functions, troubleshooting of sensors (determining bad sensors), and password assignment and modification. One training session shall be conducted at system completion, one shall be conducted forty five days after system completion, and one at ninety (90) days, or as requested by the Owner.

3.6 SERVICE GUARANTEE

A. The control system herein specified shall be free from defects in workmanship and material under normal use and service. After completion of the installation, the control manufacturer shall regulate and adjust all thermostats, control valves, motors and other equipment provided under this contract. If within twelve (12) months from date of acceptance either for beneficial use of final acceptance, whichever is earlier, any of the equipment herein described is proven to be defective in workmanship or materials, it will be replaced or repaired free of charge. The control manufacturer shall, after acceptance, provide any service incidental to the proper performance of the control system under guarantee outlined above for the period of one year. Normal maintenance of the system or adjustments of components is not to be considered part of the guarantee. The control manufacturer will upon completion of the installation, during the warranty period, make available to the Owner, an annual service agreement covering all labor and material required to efficiently maintain the control system.

3.7 FINAL ADJUSTMENT

A. After completion of installation, adjust thermostats, control valves, motors and similar equipment provided as work of this section.

B. Final adjustment shall be performed by specially trained personnel in direct employ of installer of primary temperature control system.

3.8 EXISTING CONTROLS

A. The bid for control work shall be based on the premise that existing control devices are operational and are not in need of repair or replacement unless otherwise noted.

B. Contractor shall notify the Owner of all control devices that need to be replaced or repaired that may be noticed by him in the process of installation of the new work.

END OF SECTION 23 0900

SECTION 23 0950

TESTING & BALANCING OF MECHANICAL SYSTEMS

PART 1 – GENERAL

1.1 JOB CONDITIONS

A. Systems shall be completely installed and in continuous operation as required to accomplish the tests.

B. Heating, ventilating and air conditioning equipment shall be completely installed and in continuous operation as required to accomplish the balance work specified.

C. Adjust and balance shall be performed when outside conditions approximate design conditions indicated for heating and cooling functions.

D. Make at least two inspections of the mechanical systems during construction to verify that balancing procedures may be accomplished. Report findings to the Architect/Engineer/Construction Manager.

E. Balancing firm shall balance Mechanical System two (2) times. The first time shall be considered a rough balance. Any discrepancy in air flow shall be addressed to the Architect/Engineer/Construction Manager. The final balancing will be accomplished after review of rough balance reports.

F. The final balancing reports shall be submitted and approved prior to project's being considered complete; i.e., commencement of warranties.

1.2 ENGINEER QUALIFICATIONS

A. The firm shall be an independent organization having no affiliation with construction contractors, equipment sales or design engineering.

B. The firm shall specialize in balancing heating, ventilating and air conditioning systems.

C. The firm shall show proof of having balanced and tested at least five projects of similar size and scope.

D. All field work shall be under the direct supervision of a registered Professional Engineer who is a full-time employee of the balancing firm.

E. The firm shall be certified by and a member of the AABC (Associated Air Balance Council), or NEBB (National Environmental Balancing Bureau).

1.3 REPORT

A. Data Sheets:

1. Submit data sheets on each item of testing equipment required.

2. Include name of device, manufacturer's name, model number, latest date of calibration and correction factors.

B. Report Forms:

1. Submit specimen copies of report forms.

2. Forms shall be 8-1/2 x 11 inch paper for loose-leaf binding, with blanks for listing of the required test ratings and for certification of report.

3. Reports shall be on standard forms published by AABC or NEBB.

PART 2 – PRODUCTS

2.1 AIR BALANCE INSTRUMENTS

A. Alnor Velometer with probes and alnor pitot tube.

B. Rotating Vane Anemometer: 4 inch size.

C. ASHRAE Standard Pitot Tubes, stainless steel 5/16 inch outside diameter, lengths 18 inches and 36 inches.

D. Magnehelic Differential Air Pressure Gauges, 0 to 0.5 inches, 0 to 1.0 inch and 0 to 5.0 inches water pressure ranges, each arranged as a portable unit for use with a standard Pitot tube.

E. Combination Inclined-Vertical Portable Manometer, range 0 to 5.0 inches water.

2.2 WATER BALANCING INSTRUMENTS

A. 30 Inch Mercury U-Tube Manometer, 200 psig, with 3 valve bypass assembly and return wells or mercury check valves.

B. Inspector's gauge testing set.

C. Water Differential Pressure Gauge, 4-1/2 inch dial, 0 to 100 psi range.

D. Pressure gauge measurement points, quick connect couplings, 1/4 inch psi.

2.3 SYSTEM PERFORMANCE MEASURING INSTRUMENTS

A. Insertion Thermometers, with graduation at 0.5 degrees F for air and 0.1 degrees F for water.

B. Sling Psychrometer.

PART 3 – EXECUTION

3.1 GENERAL REQUIREMENTS

A. Arrange and pay for all tests.

B. Notify Architect/Engineer/Construction Manager at least three working days in advance of test and conduct in presence of Architect/Engineer/Construction Manager.

C. Tests to be performed prior to insulation, covering or concealment.

D. Provide signed report of completion of test with signature of witnesses. Report shall indicate:

1. System Tested
2. Date
3. Specified test requirements and actual testing results

E. The balancing firm shall report to and review the work required with the Architect/Engineer before beginning field balance work. The balancing firm shall make at least two inspections of the air systems during construction and shall report his findings in writing to the Architect/Engineer.

F. The balancing firm shall cooperate with the Architect/Engineer/Construction Manager and the Mechanical Contractor to effect smooth coordination of the balancing work with the job schedule.

G. The balancing firm shall be responsible for getting the various systems into proper operation. They shall enlist the aid of the equipment suppliers and Mechanical Contractor as may be required to effect proper operation consistent with the contract plans and specifications.

H. When the balancing firm cannot balance a belt-driven piece of equipment with the supplied belts and sheaves, inform the Mechanical Contractor that the Mechanical Contractor shall provide additional sheaves as spelled out in other Division 23 Sections.

3.2 CIRCULATING WATER SYSTEM TEST

A. All piping tests shall be applied not only to piping, but also to all devices and equipment connected thereto with the exception of control valves, boilers or any other equipment which may be damaged by

the test pressure. All valves shall be full open.

B. Test at 100 psi hydrostatic pressure for 6 hours:

1. Record pressures each hour
2. Repair all leaks
3. Retest until 6 hours can be completed with no leaks or loss of pressure.

C. After completion of successful test, strainers shall be cleaned, then system shall be backflushed and strainers cleaned again.

3.3 DRAINAGE AND CONDENSATE SYSTEMS TESTING (INCLUDING EXTERIOR PIPING)

A. Disconnect all equipment and devices which may be damaged by test pressures.

B. Plug or cap lines.

C. Test each piping system for leaks in accordance with local inspection test code.

D. Repair all leaks noted.

E. Minimum test shall be to fill system to top vent stack and roof drain, and not show a drop of more than 3 inches for 1 hour. Test shall be performed before piping is concealed.

F. Secure certificate from Municipal Inspector of acceptable test.

3.4 DOMESTIC WATER & MAKE-UP WATER PIPING TESTING (INCLUDING EXTERIOR PIPING)

A. Test domestic water piping at 10 psig hydrostatic pressure for 4 hours. Drop in pressure shall not be greater than 1 psig. Use gauge calibrated in one pound increments. If test is under the jurisdiction of local inspector, his requirements may be used provided they are not less than above. Furnish signed report of test and witness.

3.5 DUCTWORK TESTING

A. Witness testing conducted by the Mechanical Contractor per Section 23 0600, PART 3: EXECUTION.

3.6 STEAM SYSTEM TEST

A. All piping tests shall be applied, only to piping. Piping test shall be made after piping is hung, supported, anchored and guided, and before insulation is applied. When leaks occur in the system, the leaks shall be repaired and retested until no leaks are present. Do not apply test pressures to control valves, coils or traps.

B. Low pressure steam and condensate piping shall be hydrostatically tested at 100 psig and with steam at 15 psig.

C. After the steam test is completed, all safety valves, strainers, traps, etc., shall be cleaned of foreign matter and the system shall be operated to prove a positive and quiet steam system circulation.

3.7 FUEL OIL SYSTEM TEST

A. All piping tests shall be applied only to piping. Piping test shall be made after all piping is hung, supported, anchored, and guided. When leaks occur in the system, the leaks shall be repaired and retested until no leaks occur.

B. All piping shall be tested under pressure or vacuum in accordance with the appropriate articles in NFPA Standards 30 and 31 that govern the installation.

C. All piping tests shall be witnesses by the Construction Manager and the Owner's Representative. A written record of the test results and witnesses shall be submitted to the Engineer.

3.8 BALANCING PROCEDURE

A. Air System Balance:

1. With the fan supply system set to handle normal minimum outdoor air, the balancing firm shall perform the following tests and compile the following information:

   Air Handling Equipment

   a. Design Conditions:

      (1) CFM Supply Air

      (2) Static Pressure

      (3) CFM Fresh Air

      (4) Fan RPM

   b. Installed Equipment:

      (1) Manufacturer

      (2) Size/Model Number

      (3) Motor HP, Voltage, Phase, Full Load Amperes

   c. Field Test:

      (1) Fan Speed

      (2) No Load Operating Amperes

      (3) Fan Motor Operating Amperes

      (4) Calculated BHP

   d. Test for Total Air:

      (1) Size of discharge, return air and outside air ducts.

      (2) Number and locations of Velocity Readings taken.

      (3) Duct Average Velocity

      (4) Total CFM

      (5) Outside Air CFM

      (6) Return Air CFM

   e. Individual Outlets (Diffusers, Registers and/or Grilles):

      (1) Identify each outlet or inlet as to location and area and fan system

      (2) Outlet, manufacture and type

      (3) Outlet size

      (4) Outlet free area, core area, or neck area

      (5) Required FPM and test velocity found for each outlet.

      (6) Required CFM and test results for each outlet

f. Test for room/space pressurization

(1) As noted on the drawings or as required, final balancing shall include room/space pressure adjustments

(2) As confirmed in writing by the Engineer, the supply, return, and/or exhaust air shall be adjusted to required pressure relationship (positive, neutral, negative) while maintaining required total air changes.

2. After completion of tests, adjustment and balancing under minimum fresh air conditions, set the system for 100% fresh air. Repeat the total CFM tests to check field versus design conditions. The results under 100% fresh air cycle shall agree with conditions found under "minimum fresh air operation" before the system is considered to be in balance. Adjustments of the proper dampers shall be made to achieve balance.

3. Testing and adjusting of individual outlets shall be performed under procedures recommended by the manufacturers of the outlets. All outlets shall be set for air pattern required and all main supply air and return air dampers to be adjusted and set for design CFM indicated. Any required changes in air patterns, settings, etc., necessary for achieving correct air balance, shall be provided by this Contractor. Total CFM of all outlets shall agree with total CFM of all branches and the grand total shall agree with the air volume for the fan(s).

B. Water Balance:

1. Water balance shall include heating water, chilled water and condenser water systems. The balancing agency shall perform the following tests, compile data and submit reports.

2. Pumps:

a. Design Data

(1) GPM, head

(2) RPM, BHP

b. Installed Equipment

(1) Manufacturer, Size

(2) Type Drive

(3) Motor HP, Volts, Cycles and Phase

(4) Full Load Amperes

c. Field Test

(1) Discharge Pressures: Full flow & no flow

(2) Suction Pressures: Full flow & no flow

(3) Operating Head and GPM

(4) No Load Amperes (where possible)

(5) Full Flow Amperes, No Flow Amperes

(6) Calculated BHP

3. Heating and/or Cooling Elements Including Loop Water to all terminal Units:

a. Design Data:

(1) MBH Specified, GPM Specified

(2) Entering Water Temperature (EWT)

(3) Entering Air Temperature (EAT)

(4) Water Temperature Drop (DTW)

(5) Element Type Specified

b. Field Test:

(1) Identify each element as to location

(2) Required water temperature drop corrected for item (3) above

(3) Actual entering air and water conditions (temperature and GPM)

(4) Adjust element until required temperature drop is obtained

C. In addition to the above work, the Balancing Firm shall check the operation of all automatic temperature control equipment; verify all thermostat, aquastat, etc., set-points and operations; and enlist the aid of the Mechanical Contractor and the Control Subcontractor to make necessary adjustments where required.

END OF SECTION 23 0950